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# THE JOURNAL OF INDUSTRIAL HYGIENE

## AND ABSTRACT OF THE LITERATURE

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The Treatment of Accidental Wounds

Researches in Mental Hygiene in Industry:
Part IV. Psychiatric Case Studies
in Department Store and Factory

Health Hazards in the Rubber Industry

A Study of Lead Poisoning among Oxyacetylene
Welders in the Scrapping of Naval Vessels

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## Journal of Industrial Hygiene

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# THE JOURNAL OF INDUSTRIAL HYGIENE

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## THE TREATMENT OF ACCIDENTAL WOUNDS*

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THE treatment of accidental wounds is a subject which may seem hackneyed. Probably no other subject has been the source of more extended or more heated controversy since the beginning of medicine, the discussion usually lying about the choice of antiseptics. Hundreds of these have been tried and discarded. Many are in more or less general use today, each with its ardent advocates. Most physicians still have their favorite.

It is the purpose of this paper to discuss the principles underlying the rational handling of such wounds and to emphasize a few practical points in their care. The excuse for so doing is an experience of ten years in handling accidental injuries. During that time over 12,000 wounds of all kinds, from the smallest scratch to the most severely complicated, lacerated, and contused wounds, have been handled. Many methods have been used and many antiseptics have been tried. In the methods now employed antiseptics have been largely eliminated.

* Received for publication Nov. 12, 1925.

### PRINCIPLES UNDERLYING RATIONAL TREATMENT

In order to treat accidental wounds rationally, one must understand and continually keep in mind the anatomy and the physiology of the tissues injured, together with the natural defenses of the body—mechanical, chemical, and biologic. One must have a clear mental picture of the minute structure and function of those tissues, especially with regard to the circulation of blood and lymph. There has never been discovered, and probably there will never be discovered, an antiseptic for wounds as efficient as blood and lymph or serum. Any antiseptic which is strong enough

to kill bacteria causes a certain amount of damage to wounded tissues. All tissue cells are more or less specialized. It is not reasonable to believe that such tissue cells have more resistance to chemical antiseptics than do bacteria which are independent, nonspecialized cells. Blood serum increases tissue cell vitality while harming bacteria; hence, it is the ideal antiseptic. No other antiseptic for wounds need be seriously considered at the present time.

During the late World War, the Carrel-Dakin method of treating war wounds was developed and has been the most valuable and practical contribution yet made to the problem of the treatment of extensive infected wounds. The efficacy of this method lies not in the antiseptic used, Dakin's hypochlorite solution, but in the asepsis and mechanical features of the treatment. For most accidental wounds as received by the surgeon doing industrial work, it is not applicable, but the principles on which its success is founded are applicable.

The purposes of the treatment of wounds are: (1) to prevent infection, and (2) to promote rapid healing. In order to do this, we need only to assist nature. In order to assist nature, we must keep in mind the natural defenses of the body against infection and her methods of repairing injured tissues. Briefly, nature prevents infection mechanically by hemorrhage, chemically by antisepsis, and biologically by phagocytosis. Blood washes out the wound, carrying away a certain amount of foreign matter, including bacteria. The blood contains certain antibodies which act as chemical antiseptics and kill bacteria, and leukocytes which engulf and digest them. Nature repairs a wound by bathing the injured tissues with serum which contains cell food, and leukocytes which digest and absorb badly damaged tissue cells. The minute blood vessels develop new loops which extend out into the damaged area, and granulation tissue or connective tissue cells build up and close the gap in the normal tissues leaving a scar or cicatrix. It is not necessary here to go into the subject of the obscure forces back of these processes. It is necessary, however, to keep these processes clearly in mind so that we may help and not hinder nature's orderly and efficient processes of protection against outside forces.

## Application of Principles

Let us take a typical wound as it comes into the dressing room. We will say that the skin and underlying tissue have been torn by steel or wood. A certain amount of foreign material, including bacteria, has been carried into the wound. It is contaminated. There has been bleeding, if bleeding is not still going on. The wound is ragged and filled, or partly filled, with clotted blood. As soon as this wound occurred, every artery, vein, capillary, and tissue space which was opened poured blood and lymph into it. This blood and lymph has washed out part of the contamination. In those parts of the wound where the circulation of the tissues has not been destroyed, most of the foreign matter, including bacteria, is in the blood clot which has

formed while the patient has been coming to the doctor's office. Those fragments or parts of tissue whose circulation has been interfered with will be most heavily contaminated.

Applying the principles above set forth to our treatment: First, the skin about the wound is cleansed with alcohol or benzine, care being taken to prevent further contamination of the wound by bacteria of the skin. If the wound is rather extensive, the skin about its margin is painted with tincture of iodine. The skin is protected by the epidermal layer of cells which are not injured by this, and bacteria on its surface are destroyed. The wound is then opened wide, forceps being used if necessary. With small gauze sponges moistened with 50 per cent. alcohol, boric acid solution, or sterile water, the wound surfaces are sponged gently to remove blood clots and foreign matter. Dry sponges damage the delicate wound surfaces, whereas wet sponges are better tolerated. This sponging should be done very gently, each sponge being used but once over the wound surface. If there are small recesses in the wound, small toothpick cotton applicators moistened with the aseptic solution are used. Alcohol used sparingly in this way does not act as an *antiseptic*. It is an *aseptic* solution with excellent cleansing powers which will not destroy living cells. We have found sterile water just as efficient, but dilute alcohol is more practical, since it can be kept in an open basin and will not harbor live bacteria. There is an additional psychologic advantage in using alcohol, in that it hurts somewhat. It is the popular idea that the germs in a wound must be killed by something strong. Fifty per cent. alcohol satisfies the patient on that score.

With a sharp, sterile knife or scissors, the damaged tissue or tissue which does not bleed is trimmed away. The overhanging margins of epithelium are trimmed off, and the wound is closed loosely by narrow strips of adhesive tape or sutures. The depth of the wound and the amount of probable future swelling must be considered in judging the tightness of closure, which should be such as to allow a rather free flow of serum from the wound for the first day or two. In most cases, adhesive strips are better than sutures.

If the wound is deep and quite ragged or badly contaminated, a narrow strip of gutta-percha or cellosilk is inserted to the bottom before closure. This aids in keeping up the flow of serum from the depth of the wound to bathe the wounded tissues with this constantly renewed antiseptic and tissue food.

A sterile dressing is applied and the patient is instructed to moisten this every two or three hours with hot water. If the wound is quite extensive or deep, the patient is instructed to keep steaming hot towels over the dressings most of the time for two or three days. This heat increases the flow of blood to the part and insures a free flow of serum over the contaminated, damaged tissues. The hot wet dressing also acts much as a wick in absorbing tissue serum and preventing its coagulation and the formation of a crust which will close

the wound. No oiled paper or silk should cover these dressings. The drying of the surface of the dressing increases absorption of serum and promotes serum discharge.

In this way, we do not attempt to kill bacteria in the wound by antiseptics introduced. We do not hope to remove all bacteria. That would be impossible. But we do keep the tissues bathed in the natural fluid which will destroy bacteria and nourish the reparative cells. Chemists have not produced any substance which will do this, or any substance which will kill bacteria in dilutions which will not injure the wounded tissue.

The following are the important points in this method:

1. Thorough cleansing of the surrounding skin.
2. Trimming away of overhanging, ragged skin margins.
3. Gentle, but thorough sponging out of the wound, removing blood clots and foreign matter.
4. Trimming away of all badly damaged tissue in the depth of the wound. This opens all capillaries and tissue spaces for the flow of serum.
5. Drainage strip, if needed.
6. Closure with judgment by adhesive strips or sutures.
7. Moist dressings, if needed.
8. Continuous moist heat in the more extensive wounds.

If wounds are handled in this manner, nature will disinfect them in forty-eight hours and healing will occur with a minimum of scar tissue. It is not necessary to use hot wet dressings in all cases, but it is always safe to use moist heat except in cold weather where the patient is working exposed to the cold. Experience alone will teach one which wounds may be safely left dry. In minor wounds where wet dressings are not used, sterile vaseline aids in the continued flow of serum better than dry gauze.

### Practical Considerations

If the wound is in close proximity with a joint, that joint should be immobilized by an appropriate splint for three to six days. Splints cut with tin shears from sheet zinc or tin have been found quite suitable for immobilizing joints of the fingers and thumbs. Zinc is better than tin as it does not rust. The same material can be used to make protecting caps for the tips of the fingers to protect wounds and allow patients to return to work. With the aid of a small pair of pliers, this sheet zinc or tin can be shaped as desired.

Punctured wounds should be opened wide by inserting the point of a sharp, narrow-bladed knife to the bottom and bringing it out in an oblique direction. In deep punctured wounds, it may be better to incise in two directions at right angles. They are then treated as lacerated wounds. A cellosilk drain is inserted for a day or two and the dressings are wet with hot water every two or three hours.

We have found it very convenient to cut cellosilk into strips of appropriate width and length and stain them in methylene blue or safranin solutions, as the transparent strips are difficult to see and handle. After staining, these strips are sterilized in 1:500 mercury bichloride solution for

two days and kept in small covered glass jars in sterile water.

In putting on dressings that are to be wet at home, allowance should be made for swelling of the part and for shrinkage of the bandage gauze, *i.e.*, the bandage should be looser than in cases where it is to be left dry.

If a wound involves a tendon or a tendon sheath, an appropriate splint should immobilize the part so that there is no motion of the tendon for four to six days. After that, motion should be started gradually.


## Summary

1. Thorough knowledge of the anatomy and the physiology of the tissues involved is necessary in the rational treatment of accidental wounds.

2. Antiseptics have very little to do with such treatment.

3. These wounds are disinfected by nature's own antiseptics in the blood and the blood serum.

4. Rational treatment consists in helping nature by certain mechanical measures outlined above.

# RESEARCHES IN MENTAL HYGIENE IN INDUSTRY: PART IV. PSYCHIATRIC CASE STUDIES IN DEPARTMENT STORE AND FACTORY*

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DURING 1924 and 1925 it fell to my lot to be attached to the medical departments of two mercantile establishments and of one factory, locally situated, in the capacity of a consultant psychiatrist. Through the courtesy of the physicians in charge of these departments a fairly large number of patients in whom mental disease or mental disorder was suspected were referred to me.

A selected number (twenty-four) of these cases were included as Part IV of a Thesis which I was preparing during that time entitled "Researches in Mental Hygiene in Industry." Each case was discussed individually not so much from the point of view of the expert psychiatrist as from the point of view of the average industrial or mercantile physician and of the personnel worker.

Because of limited space, only a few cases will be given and discussed in this paper. These cases represent fairly well the various types of mental disease or mental disorder encountered in industrial or mercantile medical practice. They suggest a practical method of handling psychiatric cases; they point out the difficulties which physician, nurse, and psychiatrist are prone to encounter in this work; and they indicate how frequently the store or factory psychiatrist must be satisfied with incomplete and unsatisfactory examinations. To the industrial or mercantile physician and nurse, the various limitations to adequate medical examination and treatment are well known. To these persons, working as they commonly do under difficulties, something accomplished now and then, a hurt healed here, an infection averted there, a lightening of life's burden for one worker here and for another there, are compensation enough. It is surprising, too, what can be accomplished under difficulties, often without adequate facilities and under restrictions dictated by store or factory policy. Another point which, it is hoped, these case studies will bring out is the value of the psychiatric method in the field of industrial medicine. (The reader is here referred to an earlier communication[1] which defines industrial psychiatry, points out the need for this specialty in the field of industrial medicine, and illustrates in a brief way the value of the psychiatric method.)

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[1] Elkind, H. B.: Industrial Psychiatry. THIS JOUR., 1924, *6*, 251.

For reasons of policy it will be necessary to make such changes in the data as will prevent identification of their source or of personalities. Except in these instances careful attention to fact will be conscientiously observed.

### Case 1. Psychoneurosis: Type?

Miss Bertha L., a salesgirl in a local department store, single, aged 43, came to the health department complaining of nervousness and of crying spells. The store physician thought of the possibility of the menopause being a precipitating cause, but referred the patient to the store psychiatrist.

The family history is negative except that one brother, at present in parts unknown, has always been considered as the "black sheep" of the family; and that another brother died of tuberculosis four months ago. Except for this brother, the patient's home has for many years been shared only with her mother. In fact, the patient is very deeply attached to her mother and has avoided matrimony in order to care for her. The mother is, of course, old and feeble and requires considerable care.

The patient's past history suggests little of importance. Before coming to the present store where she has been employed as salesgirl for over four years she had been employed in the same work by another large store for over twenty years. She has always been well except for very minor indispositions. Her menstruation has been normal except for pain the first day. She has not noticed any change of late. Until a few months ago she went out regularly to the theater, movies, etc., but recently she has spent most of her evenings at home with her mother. She has no male friends outside of the family.

Since the death four months ago of her brother, whom she regarded deeply, she has not felt the same. She finds herself worrying over many things but mainly about her mother. At times she has felt faint and numb over her body and limbs.

Physical examination is essentially negative except that the patient is slightly overweight. Her present weight (180 pounds) she has kept for many years. In giving her dreams she stated that the most frequent are about her work, her mother, and her brother. She often dreams that her mother is blind, and since the death of her brother she sees him awakening in his casket.

After discussing the case with the patient, it became quite evident that the main factor underlying the symptoms was fear of the future. Her mother could not live many more years; her brother had died recently. She began to feel the loneliness of her position in life—no home, no husband. Her mother, in a way, prevented her from enjoying the pleasures of life. This was difficult to admit but it was true. Talking over these matters appeared to relieve the patient who seemed to labor under considerable tension and who, in fact, burst into tears many times. She was told that her fears were natural but that she had sacrificed too much for her mother. She was advised, of course, to continue to care for her, but, at the same time, she was told to divide her time between duty and pleasure. A plan of living was drawn up with some recreation and a hobby included. She was given mental hygiene literature to read. She left the consultation room considerably relieved.

The patient was seen again about one week later. She reported feeling much better and expressed her gratitude for what had been done for her. She had stopped worrying and fretting, and her crying spells had ceased. She also felt that she was doing more justice to her work for, of course, her efficiency had fallen during the past few months.

This case is of interest to the mercantile and industrial physician, to the personnel worker, and to the employer of labor. It illustrates how understanding care can shorten the course of these minor illnesses, not severe enough to incapacitate the worker totally but severe enough to interfere with his or her capacity to produce or

to sell. It illustrates, too, the importance of mental and social factors in disability.

### Case 2. Compensation Neurosis? Malingering?

Miss Veronica K., a salesgirl in a local department store, single, aged 28, was referred to the store psychiatrist because the store physician thought that her prolonged convalescence might be due to a compensation neurosis. She had not worked for about two months.

About two months ago this patient was operated on for acute appendicitis. Besides this, a partial oophorectomy was performed with no drainage. The patient remained seventeen days in the hospital. At the present time, however, she does not feel able to return to work.

Physical examination is negative. The patient appears very well developed and nourished, possibly slightly obese. The abdominal scar is healed and only a slight amount of tenderness is elicited on palpation of the abdomen. The patient states that she suffers no headaches, that her appetite is excellent, that her bowels move regularly without cathartics, and that she has been sleeping very well for the past month.

Asked to explain why she does not feel able to work, the patient states that she is too weak. Questioning brings out the fact that she is apprehensive to do anything lest she injure herself. She feels that because one ovary was removed, she had a more serious operation than that of appendectomy. She also states that she should take her vacation starting two weeks hence because she has made reservations for that time. According to her statement the store management set her vacation period for her. She does not accept the suggestion that a little work at the store will help her. She believes that she ought not to return to work until after her vacation, and feels that she surely will be able to work then. She believes, too, that she should continue to receive her benefit money up to the day when her vacation commences and that she should receive her salary from the store when she is on her vacation. (It was discovered later that the patient herself, and not the management, set her vacation dates.)

The store psychiatrist advised that her benefit payments should not be continued further because there was no reason why she could not work; there was good reason to believe that she was suffering from a compensation neurosis with possibly an element of malingering entering into the situation. He advised, also, that her vacation commence at once for the whole period of two weeks and that the store should pay her salary in advance as was the custom.

This case is presented to illustrate a type of syndrome which occurs frequently in mercantile and industrial medical practice whenever the factor of compensation for illness enters. In these cases it is often difficult to differentiate between a true compensation neurosis and malingering. It is the author's opinion that quite frequently both factors enter into the picture.

### Case 3. General Paresis

Mrs. Mary T., a widow, 53 years of age, is a saleslady in a local department store. She has been in the employ of this store the past six years. Up to six months ago she had been considered fairly efficient in her work. Since that time she has fallen down in her ability to sell and has been observed to sit and dream for long periods of time. She is forgetful and cannot recognize the faces of even those with whom she has been familiar. She was referred to the health department of the store by the employment department. The store physician suspected mental disease and referred her to the outpatient department of a nearby psychopathic hospital. After being examined there she was admitted to the house for observation.

A summary of the records of the outpatient department and of the house presents the following more important facts: The family history is negative except that

the patient's husband died of tuberculosis at the age of 25. She has one son who is now 28 years of age; she has had no other children and no miscarriages. Her past history is practically negative. She did not finish grammar school. Menopause occurred seven or eight years ago. Since her husband's death she has had to earn her own living.

The patient's mental status is described as follows: "A subdued, slightly depressed woman dressed in mourning. Describes her illness vaguely, referring to it as nervousness. Rarely initiates conversation but readily responds to all questions asked. Mood somewhat depressed. Says she has blue spells, particularly when she thinks of her sister who died a few months ago, or of her son who is in Texas. Says he has grown neglectful since his marriage and she has not heard from him since February, having then received a card. No memory defect demonstrable. No hallucinations or delusions. Insight lacking."

Physical examination is practically negative except that the patient's teeth are in poor condition. The heart rate is fairly rapid with a systolic murmur over the aortic valve. The knee jerks are unequal, the right being greater than the left. The upper reflexes are normal and there is tremor of the outstretched fingers. The pupils are equal but react sluggishly to light and accommodation.

Observation in the house demonstrated that the patient's blood serum was positive for syphilis as was also the spinal fluid. (The cell count on the spinal fluid was twenty-six and the gold sol was 555444000.)

A psychometric examination was made and the patient's mental age was found to be 11 years, 5 months.

The diagnostic impression of the case was expressed as follows: The patient is "a moron 53 years of age who for the past three or four months has shown marked signs of impaired memory, at times confusing people and having complained of feeling tired. The physical signs,—irregular pupils with sluggish reaction to light, hyper-active reflectors, impaired coordination of hands and tongue, together with positive Wassermann, paretic curve in spinal fluid and increased cell count indicate General Paresis."

She was finally committed to a nearby state hospital. An excerpt from a letter received from this hospital states that "outside investigation of the case shows that she has used alcohol to excess during the past few years and occasionally has become intoxicated." It is probable that some of the symptoms in this case may be due to chronic alcoholism, as the syndrome suggests Korsakoff's syndrome.

## Case 4. Psychoneurosis: Psychasthenic Type

Miss Basche K., an assistant buyer in a local department store, single, aged 25, had six months before been injured in a sleighing party. A street car hit the sleigh and many were seriously injured, two fatally so. The patient was badly shaken up and received a severe nervous shock and some injury to her back. She remained about four weeks in bed, and after an absence of about five or six weeks returned to work. At this time she complained of more or less stomach trouble, pain in her back, and nervous headaches.

About six months after the accident she began to complain of night spells. She would awaken from her sleep with a feeling of suffocation, pain in her heart, and fear. She called a physician who thought it was her nerves. She felt that it was her heart. She then saw the store physician who advised bromides. The condition continued and she was advised to see a specialist who felt, after examining her, that she had better consult an internist. She did so, and the latter advised her that she had "intestinal stasis." Two or three weeks passed with no improvement in her condition. She was then persuaded to go to the outpatient department of a nearby psychopathic hospital. After study and observation here her condition was diagnosed as that of a psychoneurotic of the psychasthenic type.

A summary of the outpatient department records presents the following more important facts: The patient is the fifth of seven children. Her father is living and

well. Her mother is physically well, but irritable and unstable. Her family history is negative for psychopathic trends.

Birth and early history are apparently negative. The patient has had practically all the exanthemata. Catamenia began at 15. These have been irregular, the patient sometimes going as long as three months without any. Schooling commenced at 5 and she graduated from grammar school and evening high school. She was above the average in both these schools.

The patient is at present an assistant buyer in one of the larger local department stores. She has never worked for any other concern.

Her personality is described as follows: "Fond of social work; likes dancing. Reads a great deal, mostly fiction. Makes friends easily, has one intimate friend. Patient thinks she is frank and outspoken. Often displeases her acquaintances through this trait. Likes moving pictures and theaters."

Inquiry into the patient's sex life developed nothing of importance.

The present illness of the patient is given as follows: "Last winter the patient was in the . . . . sleigh ride. . . . . At the time twenty-five of the employees were in a sleigh which was struck by an electric car. . . . . Two were killed instantly and several injured. Patient was very much shaken up and remained in bed for about four weeks. Said she had at this time no desire to move. Wanted to lie quietly constantly. She returned to work some time in February. Felt all right except for a persistent fear of accidents. Never rides in a car but she feels it will collide. Six weeks ago while at Revere Beach a cannon exploded and patient was suddenly stricken with a sensation of choking and chills. Felt as if she wanted to vomit but could not on account of the feeling of constriction about her neck. Chills were very severe. Actually did vomit and relief followed at the end of an hour. About six weeks ago patient had a return of the same attack and has had about five in six weeks. In these she has a choking sensation, chills, and nausea; feels she is going to die; lasting about three quarters of an hour. After it passes off, patient is in a weakened, prostrated condition. Patient has a very definite fear of death, never had it before. . . . . Her dreams have been terrifying for the past two weeks, mostly about water and people dying. She is greatly frightened in them and she does not recede entirely from the picture for two or three days."

During her examination the patient was rather tense, speaking in a querulous tone. She gave a clear account of her illness and showed marked emotional response in relating her story. Her eyes filled and her entire attitude changed. She seemed to have more than average intelligence.

Physical examination is negative in all respects.

After her first visit to the outpatient department the patient was seen quite frequently for a few months. She was referred to an outpatient department of a local hospital for gastro-intestinal study. They found no physical basis for symptoms.

Treatment consisted essentially of psychotherapy of various sorts. The psychogenesis of her symptoms was explained to the patient and she was given some mental hygiene literature to read at home. It did not take more than two weeks for her to report improved physical and mental health. She was referred as part of the treatment to a nearby private rest home for two weeks. Soon after leaving here she returned to work in excellent health. The store nurse has since reported that the patient is doing finely and that she has said that the hospital doctor certainly helped her to find herself. Over a year has passed with no recurrence of symptoms.

This case illustrates what a store health department can do in assisting patients with nervous troubles to get relief for themselves.

### Case 5. Manic-Depressive Psychosis: Depressed Phase

Mr. Shirley L., an engraver, aged 46, employed by a large department store, was referred to a nearby psychopathic hospital for diagnosis and advice as to treat-

ment. In fact, the store physician had the patient admitted on a ten-day paper.

A summary of the hospital case records presents the following more important facts: The patient's father is living and well, though a heavy drinker. His mother is dead, cause unknown. Two sisters—twins—are patients in hospitals for the insane. One of these sisters is in a nearby state hospital with a diagnosis of manic-depressive psychosis, depressed phase. There is only one brother; he is well. No other members of family are affected by mental disease.

The patient was born near Boston. His schooling ended with the fifth grade. When 13 he went to work as an engraver and has worked in only three places since. He has had no previous hospital treatment. His marital life has been happy; he has been married twenty-three years. There have been no children, but two miscarriages. The wife died two years ago of kidney trouble.

The patient's present illness began shortly after his wife's death. This did not seriously interfere with his work. For the past two or three months he admits keeping company with a girl who works in the store with him. He will not discuss how intimate his relations were with this girl. He stopped going with her two weeks ago because he felt he could not marry her. He had to continue the support of his father, and he worried about his two sisters who are insane. He became nervous, felt his health breaking down, and thought that he had no right to go out with girls. He began to think that he had not done the right thing and he feared he was being plotted against. He says that he has no friends, that he is no good, that he has made a fool of himself, and that his life is in danger.

On mental examination his general behavior was quiet, but suspicious. He thinks people on the wards are watching him. He fears that the patients are conspiring against him and that the attendants wish to kill him. His answers are coherent and relevant. His stream of talk is normal except for content. He is normally oriented and his memory is good. He is fairly well informed. As to mood, he is in constant fear. His delusions are mainly of persecution and self-depression. He admits ideas of reference and fears being poisoned. Hallucinations were not elicited. The patient lacks insight. He realizes, however, that he is nervous and that he may become mentally ill if things keep on as they have been. A psychometric examination was made and the patient attained a mental age of between 13 and 14.

The patient did not improve during his short stay at the hospital and he was committed to a nearby state hospital.

This case was efficiently handled by the store physician who recognized the mental nature of the malady and promptly had the patient admitted to a psychopathic hospital for observation.

### Case 6. Psychoneurosis: Neurasthenic Type? Compensation Neurosis

Mrs. Anna T., factory worker, married, aged 36, had been out ill and drawing benefit money for a number of months. The doctor in charge of the benefit office had examined her and could not find cause for her being away from work so long. For this reason she was referred to a psychiatrist for examination and study.

The family history is negative for psychopathic trends. The patient is married and her husband is living. He is a common laborer and has not been employed for some months. There are three children, aged 16, 12, and 9. The oldest works in a factory and earns $9 weekly. The home is located in a poor neighborhood.

The patient was born in Italy. She is not able to give any information about her birth or early development. (She speaks poor English.) She had measles and mumps when a child. There have been no serious illnesses until four years ago when she began to complain of stomach trouble which was probably caused by appendicitis. Appendectomy was performed about three years ago. Menstruation has been scanty for a number of years but has been regular. There is considerable leukorrhea but very little pain.

The patient has never gone to school and can neither read nor write Italian or English. She possesses a fair knowledge of broken English. At times it was difficult for her to understand the examiner. There is a very slight but customary use of wine, but no hard liquors are used. No excessive use of coffee or of tea. No sexual perversions were made out. She complains, however, that her husband is excessive in his demands. She says she reacts coldly to sexual relations. She also says that her husband is affectionate and treats her well. She is not jealous of him nor does she suspect any infidelity on his part. She also says she likes him. He is a man of good habits and has never been intoxicated. At the present time he is unemployed, having been laid off about four months ago.

The patient's personality may be described as that of an inferior type. She appears asthenic and seems to exaggerate her symptoms. She avows her desire to work and yet strongly objects to returning to work. She complains of eructations of gas and has attacks when talking of her illness. She forgets this when absorbed in some interesting topic. She is of slight build, appears somewhat anemic, and seems to have lost weight.

Her present illness began about four years ago. The symptoms mainly complained of have been gastric in type. She has continued working in spite of her illness but found it necessary to give up about five months ago. She is now receiving $12 a week from the factory benefit plan, while her normal wages for some time have ranged from $16 to $19. She would probably now be receiving less owing to a general decrease in wages caused by the recent business depression. At the present time her husband is not working and has not been for the past four months. (There is a question whether or not the family is receiving aid from the Overseers of the Poor of the town in which they live.)

The patient complains of general aches and pains, gastric distress, and eructations of gas. She has no headaches and has never vomited. Two months ago she had a short period of nausea. Her bowels are moving daily at the present time with the aid of cathartics, but previously they have been poor. During the past few months she has been an outpatient of two excellent general hospitals, both of which have made the diagnosis of no physical disease except ptosis of the stomach. She was advised by both to wear surgical corsets. She says that there is some improvement since she has been wearing them. She has remained home the greater part of the time staying in bed with little or no sleep at night. On account of her father's death two months ago, she has not gone to amusements of any sort. Her home interests seem narrow. She resents the suggestion that she is able to work.

The mental status of the patient may be described as follows: She is poorly but neatly dressed. She is quiet and cooperative during the examination. Because of language difficulty it is almost impossible to get a clear picture of the content of her thoughts. She speaks in broken English but coherently. Her mood appears normal though there seems to be an unconscious attempt to simulate distress. No examination of her intellectual functions was made. Whether or not she has insight into her condition is difficult to say. No delusions nor hallucinations were made out.

The patient is poorly developed and nourished. Her pupils are negative. Her teeth are in a fairly good condition; there is, however, some foulness of the breath. Her tonsils were not seen. Her heart is negative except for a faint murmur heard only at the apex, probably functional. Her abdomen is flabby and striated. There is an abdominal scar in the right lower quadrant due to a McBurney's incision. No gynecologic examination was made. (Gastro-enteroptosis is probable.) Physical examination is otherwise negative.

It appeared to the examiner that this patient was an inferior person, both as to physical development and as to mental equipment. The symptoms seemed in part to be residuals following an appendectomy which have been utilized as a means of resolving difficult situations in her life. It seemed, however, that the process in the main was based on a desire to continue her invalidism in order to secure without working compensation which

was very near in amount to her full wages. Moreover, full wages were not commonly being paid at this time. This process was helped along by outpatient physicians who told the patient that she was seriously ill, that she should rest a good deal and even stay in bed. No wonder her muscles became atonic after a while and that any effort to work caused early fatigue. Therapy was advised on these premises.

The patient was told that her benefit payments would still be continued without any reduction. She was also advised to work as long as she felt able and that she would be paid at a maximum rate for whatever she made. She was told to try to get up to four hours daily as quickly as possible. The psychogenetic character of her symptoms was explained to her as well as one could under the circumstances. She was told not to go to bed during the day, and was advised to eat almost anything she craved and to forget all dietary systems previously prescribed for her. Moving pictures or some other form of amusement were also suggested as a means of helping her back to economic efficiency. An iron tonic in pill form was prescribed. She promised to start work the next day. Meanwhile the department superintendent was apprised of the plan and he consented to co-operate.

It was about a week before this patient could make up her mind to fall in with this plan. At the end of a week she was working four hours daily and beginning to like it. A new but relatively easy job had been picked out for her, but after a few days she objected and wanted her old job back again, which was in fact a little more difficult than the job to which she had been first assigned. After two weeks or so she seemed much better both physically and mentally. She appeared stimulated by the relatively high wages she was receiving.

A shutdown of the whole plant interrupted this plan for about a month. When the factory reopened, however, she was ready for work. After a week or so she began to work more than four hours daily. This was allowed to go on for a while. Then she was told that she had proved she could work, that her benefit payments would be stopped, but that she would be guaranteed full time and maximum wages. She consented to this plan—how readily it was difficult to ascertain—and is now working eight hours practically every day and hardly ever complains of illness.

This case illustrates a common occurrence in accident or sickness insurance practice, especially when operated under factory or mercantile auspices. The coddling of nonindustrial physicians who are not trained in psychiatric method is an important factor. Another factor, of course, is the relative ease with which one can prolong convalescence and receive during this period financial aid almost equal to what one could earn if working under usual conditions. The treatment used in this case is suggestive of what might be tried profitably in similar cases. It also gives hints for prevention. It seems, too, that some method of benefit payments should be devised which would pay premiums to workers for returning to their jobs when physically and mentally able rather than to pay premiums for remaining away until the last possible moment, as is now rather commonly done.

## Summary

The foregoing paper is a selection of six case studies that were made by the author in the capacity of a consulting psychiatrist to health departments in a number of local department stores and factories. These cases illustrate in an approximate way the type of cases which are fairly commonly met with by the industrial and mercantile physician or psychiatrist.

The first is a case of psychoneurosis, the type of which is not definite; the second is a case where a compensation

neurosis and malingering are the most probable diagnoses; the third is a case of general paresis; the fourth, a case of psychoneurosis of the psychasthenic type; the fifth, a case of manic-depressive psychosis in the depressed phase; while the sixth and last case presented is a psychoneurosis of the neurasthenic type with compensation neurotic features.

The paper as a whole points out quite definitely the value of psychiatry in industrial and mercantile medical practice.

J. I. H.
March, 1926

# HEALTH HAZARDS IN THE RUBBER INDUSTRY*

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THE purpose of this article is to present briefly the most important health hazards related to employment in the rubber industry.[1] The accident hazards of the industry are not unusual. The most important have to do with the handling of the heavier materials and equipment, with the milling operations, and with the small hand tool injuries.

Our real interest on this occasion has to do with the various chemicals used in rubber manufacturing processes, capable of causing a detrimental effect on the health of workers or, in other words, of causing occupational diseases.

Occupational diseases may be defined as pathologic conditions caused by exposure to toxic agents, infectious organisms, or faulty environment under specific conditions of employment. They may be acute or chronic.

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[1] The author is indebted to current textbooks and publications such as "Industrial Health" by G. M. Kober and E. R. Hayhurst, Philadelphia, P. Blakiston's Son & Co.; "Industrial Poisons Used in the Rubber Industry" by Alice Hamilton, U. S. Bur. Labor Statistics, Bull. No. 179, Oct., 1915; together with various publications of the Rubber Section, National Safety Council.

## Toxic Chemicals

So far as we know there are no infectious organisms peculiar to the rubber industry capable of causing occupational diseases. The working environment in the industry is not, generally speaking, antagonistic to health. There are, however, a number of chemicals widely used, some of which are important, or may be important to the health of workers in the rubber industry. Exposure to these chemicals is largely limited to certain processes or to certain stages in other processes. For instance, the lead hazard is largely limited to the compounding and mixing processes. When once the lead has become thoroughly incorporated in a mass of rubber, it ceases to be a hazard of consequence. Urotropine may be a hazard throughout a number of the stages of the manufacturing processes, but its use as an accelerator is rather definitely limited to certain types of product. Benzol is a hazard only in those processes where it is used as a solvent.

These toxic chemicals occur in the forms of solids, liquids, and gases, and they may enter the body either through the respiratory or the digestive system, or through skin absorption. The most important of these chemicals are:

Lead.
Aniline.
Benzol.
Hexamethylenetetramine.

Of lesser importance, either because they are less toxic or less used are:

Antimony.
Benzine.
Carbon disulphide.
Carbon tetrachloride.
Sulphur chloride.
Numerous accelerators.

Let us now consider something of the chemistry, uses, dangers, symptoms, measures of relief, and methods of prevention of poisoning by these chemicals.

### *Lead*

The compounds of lead which are used most frequently are white lead, the basic carbonate; and litharge, the yellow oxide.

*Dangers.*—Of the lead compounds used, the most dangerous is probably white lead. While this material is more soluble than litharge, and, quantity for quantity, is more poisonous, it is not so light and fluffy; and therefore from a practical standpoint it is probably less dangerous. Litharge is of much more importance than white lead because it is used more frequently and in larger quantities.

The lead is usually taken into the system in the form of a dust and is absorbed either through the respiratory system or through the digestive organs. It is likewise taken into the body by means of contaminated food and through chewing tobacco.

*Symptoms.*—Industrial lead poisoning appears as a rule in the chronic form and arises from continuous absorption of the most infinitesimal quantities of lead during a protracted period of time (weeks, months, and even years).

The beginning is insidious, with disturbances of the general health, a sense of weakness, decline of bodily strength; sallow, pale yellowish hue of the skin; distress in the region of the stomach, eructations, lack of appetite, metallic taste in the mouth, and fetid breath.

Other symptoms are the blue line (blue-gray discoloration of the gums) which, however, may be absent, even in the course of a severe attack; lead colic with most obstinate constipation, retention of urine; plumbic arthralgia (lacerating, boring), occurring for the most part paroxysmally, chiefly in the lower extremities, more rarely in the upper, often interpreted as a symptom of rheumatism of the joints, with, frequently, fibrillar trembling of the fingers. Typical are the lead paralyses, of which disturbances of sensation (paresthesia and esthesia) take the precedence. Paralysis generally affects the extensor muscles of the arm and hand, with atrophic manifestation; more rarely it affects the flexor muscles. Sometimes also there are paralyses of the extensors and flexors of the lower extremities or of the muscles of the shoulder. From experience it is known that those groups of muscles are especially affected which are most used in the occupational activity. Transient blindness may occur, and also gradually progressive atrophy of the optic nerve; temporary loss of the special senses of smell and taste; violent, often fatally ending diseases

of the brain (saturnine encephalopathy), sometimes preceded only by slight premonitory symptoms, such as irritability and headache, ringing in the ears, insomnia; but more often preceded by slowly increasing mental disturbances; epileptiform convulsions, hallucinations; morbid changes in the blood vessels and in the heart and kidneys (contracted kidney); increase in blood pressure and granular degeneration of the red blood corpuscles.

*Measures of Relief.*—Discontinuance of work in lead at the slightest symptoms of lead poisoning is necessary for relief.

*Methods of Prevention.*—Poisoning by lead may be guarded against by frequent physical examination of all employees exposed to a lead hazard, such examination to include chemical examination of urine and feces for lead. Sifting of lead should be done in air tight containers, and compounding and mixing operations should be adequately ventilated. Eating of lunches and the chewing of tobacco should be prohibited within the workrooms. Lunch rooms separate from the work space, facilities for frequent changes of clothing, shower compartments, and hot water should be provided. Where lead cannot be replaced with a less dangerous accelerator, some companies have successfully used the "mother batch" method of control. The lead is mixed either with rubber or with some oil base, and the mixed material is then incorporated into the rubber. Where this method of control has been used the danger from excessive lead dust in the compounding and mixing rooms has been reduced to a considerable extent.

### *Aniline*

$C_6H_5NH_2$ is commonly known as "aniline oil." Formerly it was used extensively as an accelerator of vulcanization, but it is gradually being replaced by less dangerous compounds.

*Dangers.*—Aniline may be absorbed through the skin, by direct contact or by saturation of the clothing; through the digestive organs; or through the respiratory organs. Exposure need not be for a long time or to large amounts. Several fatal cases are on record where the exposure continued for less than three hours.

*Symptoms: Acute Poisoning.*—In mild cases the symptoms are: pallor of the skin and mucous membranes, with slight cyanosis; a feeling of weariness and weakness; vertigo, reeling, unsteady gait; deficient elasticity of movements; slow, labored speech; irritability (aniline "pip"); condition of slight inebriation, with loquacity, gaiety, and defective power of orientation; loss of appetite; constipation; and tense, rapid pulse.

In severe cases the symptoms are: dark blue to swarthy cyanosis; formation of methemoglobin; bounding pulse; "air-hunger," with great frequency of respiration; lowering of sensibility; obliteration of the reflexes; sometimes vomiting, strangury, and bloody urine.

In the most serious cases the symptoms are: sudden prostration; pale skin, blue lips, nose, and ears; diminution and even extinction of sensibility; moist, cold skin; small pulse; death in a comatose condition, sometimes after antecedent convulsions.

*Symptoms: Subacute and Chronic Poisoning.*—These symptoms are: anemia; slowing of the pulse; disorders of digestion, such as eructations, loathing of food, vomiting, diarrhea, and eczematous and pustular eruptions on various parts of the body, especially on the scrotum. Nervous symptoms are: general debility, headache, ringing in the ears, vertigo, unrestful sleep, disturbances of sensibility, often of motility. Spasmodic poisonings are very rare. Anemia and retarded pulse are early symptoms.

The blood is of a brownish hue, but microscopically unchanged; occasionally the urine contains blood.

*Measures of Relief.*—At the first symptoms of the poisoning immediate removal from the workroom to a cool, shady spot should be effected; also removal of clothing; cool water on the body; artificial respiration with oxygen; copious ingestion of milk; in cases of weakened heart action, stimulants (black coffee, or camphor, but no alcohol).

*Methods of Prevention.*—A less dangerous accelerator should be substituted for aniline.

### *Benzol*

Benzol ($C_6H_6$) is also known as benzene. The usual commercial products of benzol are:

(*a*) Pure benzol, which is a clear, colorless liquid of a characteristic odor. Many of the cases of poisoning reported in the rubber industry are believed to have been due to the pure benzol.

(*b*) Ninety per cent. benzol, so called because in the distillation 90 per cent. should distil over at a temperature below 100°C. It is composed of 80 to 85 per cent. benzol, 13 to 15 per cent. toluene, 2 to 3 per cent. xylene, and it contains as impurities traces of olefines, paraffins, sulphuretted hydrogen, and other bodies.

(*c*) Fifty per cent. benzol, which contains 50 per cent. of constituents which distil below 100°C. and 90 per cent. below 120°C. It is a very mixed product, containing only 40 to 50 per cent. benzol.

(*d*) Solvent naphtha, so called because it is used extensively (especially in England) for dissolving rubber. It is free from benzol, but contains xylene and its homologues and other unknown hydrocarbons. Solvent naphtha is sometimes known in the trade as "benzine," and this unfortunately often leads to its confusion with petroleum benzine (see *Benzine*) and to mistakes in accounts of poisoning.

*Dangers.*—Dangers from benzol may come from absorption through the lungs by breathing, and from absorption through the skin. There seems to be some difference in the toxicity of pure and commercial benzol. The older reports indicated that the commercial benzols were more dangerous than the pure, but the experience of the rubber industry would seem to indicate that this conclusion is unfounded. There seems to be a direct connection between the boiling point of these solvents and their power to do harm; the solvents of low boiling points appearing to be more dangerous than those of higher boiling points. This is probably due to the fact that the amount of vapor given off into the air is greater with benzols of lower boiling point, and thus a larger dose

is breathed by employees exposed to the material.

Considerable variations in individual susceptibility exist. So far as age is concerned, the dangers appear to be equal to all ages. Females seem to be more liable to benzol poisoning than males. Vigorous, muscular individuals who have rapid circulation and deep breathing are overcome by benzol fumes more readily. On hot, humid days, or in interiors where the air is hot and stagnant, poisoning is more likely to occur because of the greater volatility of the benzol under these conditions, and also perhaps because of the increased pulse rate, and hence the greater flow of blood through the lungs.

*Symptoms: Acute Poisoning.*—In mild cases, symptoms are cerebral disturbances, humming in the ears, giddiness, somnolence, a condition resembling inebriation, vomiting and irritant cough, slight flushing of the face. There is often euphoria.

In severe cases, symptoms on the part of the central nervous system are: muscular tremor, like chilliness from exposure to cold; trembling of the whole extremities; finally, tonic and clonic spasms. Other symptoms are: euphoria; pale, livid skin; lips remarkably scarlet-hued; blood, bright red, thin. Discolorations of the skin, like those in aniline and nitrobenzol poisoning, are wanting in benzol poisoning.

In the most violent cases, there may be hallucinations, delirium, protracted unconsciousness, and death in tonic convulsions.

*Symptoms: Subacute and Chronic Poisoning.*—These symptoms are: numerous spots of extravasated blood in the skin (petechiae) similar to those of morbus maculosus, together with severe anemia; hemorrhage from the mucous membranes—in women, from the genitals; fatty degeneration of the internal organs (heart, liver, kidneys).

*Measures of Relief.*—Relief may be brought about through: prompt removal of the patient into the fresh air; inhalation of oxygen.

*Methods of Prevention.*—Rigid physical examination each month, including differential blood count and coagulation time, of all employees exposed to benzol may help in guarding against benzol poisoning. Reduction in white blood cells or increase in coagulating time (outside of reasonable limits) should call for a change in the occupation of the employee. Workers should be free from any organic disease, especially of the kidneys or heart, as these diseases tend to retard elimination.

Female workers should be excluded from operations where benzol is used and where adequate ventilation is not maintained. Ventilation should be by means of a downward current of air; the velocity of the air current (toward the floor) should be not less than 6 feet per minute. Outlets for ventilating systems should be at the floor level. Because of the difficulty in localizing the benzol vapor, general room ventilation is recommended as being superior to the hooding of specific operations.

The Third Progress Report of The Sub-Committee on Benzol, Chemical Section, National Safety Council, indicates that probably the use of xylol, toluol, and hiflash naphtha will eliminate the serious dangers present in benzol; and the suggestion is offered by the Sub-Committee that these

relatively harmless solvents might be substituted for the benzol.

### *Hexamethylenetetramine*

Hexamethylenetetramine ($(CH_2)_6N_4$) is known in the rubber trade as "hexa," and is sometimes sold under various trade names. It is also known as hexamethylenamine, aminoform, urotropine, cystamine, and cystogen. It is used extensively as an accelerator of vulcanization.

*Dangers.*—The free phosphoric acid in the sweat of the employee appears to break down the structure of this compound, with the liberation probably of acetaldehyde. The aldehyde compound, in turn, oxidizes to formic acid, causing skin irritation, which—in most cases—rapidly clears up when the employee is removed from contact with the "hexa." In many cases, where the exposure is continued over a long period, secondary eczema which responds slowly to treatment is not unusual. Except for the skin eruptions and for the inconvenience suffered by the employees by frequent lay offs, this material is not dangerous; it has, however, been the cause of some labor turnover within departments, as the employees object to constant skin irritations. Blond persons are said to be more susceptible to the rash than persons of dark skin; this apparently is due to the difference in the chemistry of the sweat.

*Symptoms.*—Symptoms are: intense irritation of the skin, usually beginning on the arms and legs and extending to the body, face, and head. In severe cases, blisters filled with watery fluid result.

*Measures of Relief.*—Relief may be procured through: change of occupation to a process where "hexa" stock is not handled; treatment of the rash with alkaline washes.

*Methods of Prevention.*—Poisoning may be prevented by the substitution of other accelerators for "hexa;" by personal cleanliness on the part of employees, including frequent washing of the hands and arms during the working period, and a shower bath at the close of the shift; and by frequent change of clothing. Some rubber concerns have experimented with the use of bicarbonate of soda and of borax on the arms of the employees as a means of preventing the rash, by neutralizing the acid of the sweat.

### *Antimony*

Antimony is usually obtained in the rubber industry in the form of antimony pentasulphide, or golden sulphide of antimony, $Sb_2S_5$.

*Dangers.*—The antimony compounds used extensively in the rubber industry are somewhat insoluble in dilute acids, and for this reason are probably not serious hazards to the employees exposed to them.

*Symptoms.*—Symptoms are: itching eruptions of the skin caused by local irritation; inflammation of the mouth, throat, and stomach; constipation and intestinal colic; in acute cases, diarrhea, albumin in the urine, loss of strength, weakness of the heart, vertigo, and faintness.

*Measures of Relief.*—Symptoms should be treated by a physician.

*Methods of Prevention.*—Poisoning may be prevented by: sifting compounds in closed containers; adequate ventilation in compound and mixing

rooms; and personal cleanliness on the part of employees.

### *Benzine*

Benzine is called naphtha, gasoline, petroleum ether, benzin, petrol naphtha, canadol, ligroine, and rhigoline. This material represents a group of hydrocarbons which distil from crude petroleum at various temperatures, usually under 135°C. It is used extensively as a solvent in the rubber industry.

*Dangers.*—To the few persons susceptible to poisoning from this substance, the vapor of benzine presents some danger. The higher grades of benzine, because of their low boiling points, contaminate the air more rapidly than do the lower grades.

*Symptoms.*—The symptoms in cases of benzine poisoning vary greatly because the benzine used technically is a complex mixture and is not always of the same composition.

*Symptoms: Acute Cases.*—Symptoms are: headache, vertigo, nausea, vomiting, cough, irregular respiration; drowsiness and deep sleep with coldness of the skin and complete insensibility; on awakening, headache, vertigo, and depression, fibrillar twitching of the muscles, trembling as if from chilliness; benzoic acid found in the urine. The effects of acute poisoning from breathing moderate amounts of benzine resemble mild alcoholic intoxication, and in spreader rooms where employees are familiar with the condition, they speak of it as "naphtha jag."

*Symptoms: Chronic Cases.*—The occurrence of chronic poisoning by benzine has been contested by a number of investigators. No cases of alleged chronic poisoning from this cause have been reported in the rubber industry. In those industries where chronic poisoning is said to have occurred, the symptoms have been headache, flashes before the eyes, ringing in the ears, psychosis with excitement and a state resembling drunkenness, sensory disturbances and hallucinations.

*Measures of Relief.*—Relief may be brought about through: removal of the patient into fresh air; in severe cases, stimulants like coffee or camphor, then cold affusions.

*Methods of Prevention.*—Benzine (do not mistake for benzol) is probably the least dangerous of rubber solvents. Many of the symptoms of poisoning can be prevented by adequate ventilation of the work spaces. Where artificial ventilation is required, care should be taken to have the vapors exhausted below the breathing zone of the employees.

### *Carbon Disulphide*

Carbon disulphide ($CS_2$), also known as carbon bisulphide, is a clear, colorless neutral liquid, used in the rubber industry usually in connection with sulphur chloride in the "cold cure" process.

*Dangers.*—Carbon disulphide may gain entrance into the body in the form of a vapor through respiration, or in a fluid form through the skin. This material does heavy damage to the red blood corpuscles and to the central nervous system.

*Symptoms: Acute Poisoning.*—In mild cases, the symptoms are: marked stupefaction and a sense of intoxication. In more intense poisoning: pallor of the countenance, flaccidity of

the arms and legs, even complete insensibility, obliteration of all reflexes, loss of consciousness, due to paralysis of the nervous system. With the inhalation of concentrated vapor there is a fatal result in a few minutes.

*Symptoms: Chronic Poisoning.*—The earliest symptoms (first becoming manifest sometimes after employment for a few weeks, but, for the most part, after months or even years) are headache, extending from the root of the nose to the temples, a sensation of giddiness and stupefaction, particularly at evening after the close of labor; later, pain in the extremities, muscular weakness with trembling, spasms or fibrillar twitching, also contractures, transient and permanent paralysis, with atrophy of the muscles; deafness; itching and formication on the skin, reduction of the reflexes, circumscribed and more extensive areas of anesthesia and analgesia; acceleration of the heart's action, nausea, vomiting, colic, alternate diarrhea and constipation, the latter condition prevailing in the later stages of the disease; emaciation; disturbance of the sense of vision, sometimes transient, but rare in the initial stage; retrobulbar neuritis, choroiditis, central scotoma; disturbances of the senses of smell and taste. In respect to the central nervous system there is at first a condition of excitement, followed by depression; subsequently, very irritable, violent, and explosive temper, with hyperstimulation of the sexual instinct; later, its abnormal decline. After several weeks or months: relaxation, melancholy, a dreamy manner, weakness of memory, puerile enunciation, and obtuseness.

According to Charcot, psychic disturbances occur in 87.5 per cent. of the cases. Mental diseases under the semblance of acute mania and dementia occur with good prospect of recovery; the severer forms appear in cases where there is hereditary predisposition. There have been observed also local evidences of the paralyzing effect of the carbon disulphide on the parts brought into contact with it, especially in the fingers.

The prognosis, so far as the preservation of life is concerned, is favorable; as to the full restoration of health, it is unfavorable.

*Measures of Relief.*—In cases of acute poisoning, remove the patient to the fresh air, give him a warm bath or cold affusions, accordingly as excitement or stupor prevails. Artificial respiration may be necessary. For subacute or chronic symptoms the patient should quit the work at once. He should be given nitrogenous food to prevent muscular atrophy, with such drugs as strychnine, quinine, phosphorus, iron, iodides, and arsenic. For the muscular conditions, electricity (galvanism), vapor baths, and massage are indicated.

*Methods of Prevention.*—Prophylaxis is usually easy. Workers should stand on raised platforms, not down in pits or low places. They should be selected, instructed, alternated, and allowed only short applications at this work. They should wear impervious clothing, rubber gloves, and boots. Local exhaust systems; slatted floors with powerful exhausts beneath; fresh air from windows stirred up by electric fans; the process confined within special cupboards with apparatus for subsequently drying the goods, all handled mechanically—these are some

of the various means employed to prevent poisoning. It should be remembered that clothes, hands, walls, floors, etc., become impregnated with carbon disulphide and that all need thorough and frequent cleaning. The hands and fingers should especially be kept out of carbon disulphide solutions.

Carbon tetrachloride is the natural substitute, having many advantages, but is more expensive. It is, however, extensively used in Ohio. Some patent harmless substitutes are also on the market. Substitution of other curing processes (steam, vapor cures with sulphur monochloride alone, sulphur chloride with carbon tetrachloride, etc.) have largely replaced the old "acid" or "cold" cure in rubber districts.

### *Carbon Tetrachloride*

Carbon tetrachloride ($CCl_4$), known also as tetrachloromethane and perchloromethane, is a heavy, colorless fluid of an agreeable aromatic odor. It is used extensively as a substitute for carbon disulphide in the rubber industry.

*Dangers.*—The dangers from the use of this material arise principally from the carbon disulphide which is present as an impurity in the commercial tetrachloride. So far as its poisonous qualities are concerned, carbon tetrachloride is to be preferred to other solvents. It has the great advantage of being noninflammable.

*Symptoms.*—For symptoms of poisoning by carbon disulphide as an impurity in carbon tetrachloride, see under *Carbon Disulphide.*

*Methods of Prevention.*—Carbon tetrachloride which is relatively free from carbon disulqhide should be used and adequate ventilation maintained.

### *Sulphur Chloride*

Sulphur chloride ($S_2Cl_2$), known also as sulphur subchloride and sulphur monochloride, is used with carbon disulphide, carbon tetrachloride, benzol, or naphtha (usually with the first two) in the "cold" cure vulcanization process.

*Dangers.*—The chief danger from this material comes from its being broken up by moisture (steam) into sulphur dioxide and hydrochloric acid, the latter material causing inflammation of the respiratory organs. When used in connection with carbon disulphide (as it usually is in the rubber industry), the dangers from the carbon disulphide are more pronounced than those from the sulphur chloride.

### *Para-Nitrosodimethylaniline*

Para-nitrosodimethylaniline ($NO \cdot C_6H_4N(CH_3)_2$) is a greenish compound sometimes used as an accelerator of vulcanization in the rubber industry. Where this material is used, the employees exposed to its dangers sometimes suffer with a severe inflammation of the skin which increases in severity according to length of exposure. It is known in the trade also under the name "accelerine."

*Methods of Prevention.*—Personal cleanliness of the employee and adequate ventilation appear to be the best preventives. Change of occupation will cause the rash to disappear, leaving no permanent effects. Where possible this compound should be replaced by some less toxic accelerator.

### *Para-Phenylenediamine*

Para-phenylenediamine ($C_6H_4(NH_2)_2$) is known also as para-diaminobenzene. This substance is in the form of reddish, crystalline leaflets. It is sometimes used as an accelerator of vulcanization, and is sold to the rubber trade under several trade names.

*Dangers.*—This is probably the most dangerous of all accelerators. Inhalation of the dust gives symptoms of a common cold with sneezing and depression. The irritant action of this substance is prominent; it produces skin affections, inflammation of the mucous membranes, more especially of the respiratory organs, and sometimes inflammation of the kidneys. The general effect of para-phenylenediamine is an irritant one upon the central nervous system.

*Methods of Prevention.*—The dangers from this compound are by far too great to permit its use in the rubber industry. Other accelerators should be substituted for this material. Accelerators which are reddish in color and are purchased under trade names should be considered with suspicion until the absence of para-phenylenediamine is proved.

### *Thiocarbanilide*

Thiocarbanilide ($CS(NHC_6H_5)_2$) is known also as sulphocarbanilide. This material is manufactured by boiling aniline with alcohol and carbon disulphide and is apt to contain as impurities traces of both the aniline and the carbon disulphide.

*Dangers.*—When heated to vulcanization temperatures, this material decomposes with the formation of thiocarbanil (phenylmustard oil).

*Symptoms.*—The fumes of thiocarbanil (see foregoing paragraph) cause pallor and blueness of the gums and the lips.

*Measures of Relief.*—Remove the patient to the fresh air. Symptoms should be treated by a physician.

*Methods of Prevention.*—Prevention of poisoning should be insured through ventilation of the pressroom where thiocarbanilide is used. Immediate attention should be given to early symptoms, and a temporary change in occupation made.

## Summary

The dangers and symptoms of toxic chemicals used in the rubber industry are enumerated, together with possible measures of relief and methods of prevention of poisoning by these chemicals. The chemicals considered are:

Lead.
Aniline.
Benzol (benzene) and solvent naphtha.
Hexamethylenetetramine.
Antimony.
Benzine.
Carbon disulphide.
Carbon tetrachloride.
Sulphur chloride.
Para-nitrosodimethylaniline.
Para-phenylenediamine.
Thiocarbanilide.

# A STUDY OF LEAD POISONING AMONG OXYACETYLENE WELDERS IN THE SCRAPPING OF NAVAL VESSELS*

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## INTRODUCTION

THE object of this paper is to present the results of a study of lead poisoning among gas welders employed in the cutting up of old battleships at the Navy Yard, Philadelphia, Pa. These ships which have been scrapped in conformity with the Limitation of Armament Treaty are the South Carolina, the Minnesota, the Delaware, the New Hampshire, the Michigan, and the Kansas.

A brief account of the general procedure of the demolition of these old ships may be of interest in this connection. The ship breaker, after scrapping the ship of her comparatively light and easily detached interior fittings, proceeds to remove the masts, smokestacks, bridges, and superstructure so as to open up extensive spaces in her upper decks to facilitate her disemboweling. Air driven socket wrenches run off the heavy nuts, and pneumatic hammers punch the deck bolts and other bolts out of their holes.

Depending on the point of attack, oxyacetylene torches and pneumatic chippers make relatively quick work of the thinner metal fabric. The major part of the cutting and dismantling is done by pneumatic tools and by the fusing heat of the oxyacetylene torch.

Whether the scraps be chunks of armor plate or sections of structural steelwork, none of these can be more than 2 feet long and 18 inches square if they are to enter the open hearth furnace and be utilized as remelting stock. Accordingly it is self-evident that many oxyacetylene torches must be kept busy in reducing a battleship to a marketable scrap. These great steel bodies, therefore, are converted into scrap metal by burning or cutting out myriads of rivets, by driving out a seemingly endless number of bolts, and by cutting up metallic features of the quondam battlecraft into blocks and converting them into other useful forms.

Most of the metal cutting is done by means of the fusing oxyacetylene torch. This apparatus has proved an invaluable aid in ship scrapping, but its employment under certain conditions has been found a serious menace to the physical well-being of the gas welders. This has been notably the case during certain stages of the work inside some of the vessels and especially in compartments no longer ventilated artificially as was the case when

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the ship was in commission. During the active life of a normal ship her metal work receives many coats of paint and the thickness of this built-up veneer has been found to be one-quarter of an inch thick. Pneumatic chippers are employed to cut away the paint from the metal as far as possible before bringing the torches into action. This process greatly reduces the volume of smoke, but there are many locations not readily accessible to it. A certain amount of the residue remains after the chipping; unless the flame is very carefully applied along the line previously chipped, it spreads outside of the clean area. The relief obtained is, therefore, only partial.

FIG. 1.—Showing oxyacetylene burner in position for burning.

FIG. 2.—Showing oxyacetylene flame in actual use.

frequently as much as one-quarter of an inch. When the flame of the oxyacetylene torch is applied to melt the metal, a dense smoke is given off. The temperature of the oxyacetylene flame being 3,600°F., the lead contained in the paint is readily volatilized. The inhalation of these fumes naturally involves a serious risk of lead poisoning.

The work consists in applying the oxyacetylene flame by means of a special holder, and in carrying the burner along the special line of the armor or structural plating to be cut (see Figs. 1 and 2). Poisoning of course can result only when the surfaces have been previously painted with lead paint or when the flame in cutting through comes into contact with red lead calking which may be as much as

The Department of Factories and Workshops of Great Britain has also been confronted with the prevalence of plumbism in ship scrapping operations. Experiments by the principal chemist of the government laboratory of the Department as reported by Legge (1) (2) have shown that 49 mg. of lead per 10 cubic meters of air were given off during a burning experiment in which actual working con-

ditions were closely simulated. This represents the maximum amount which a burner could breathe during a full working day, and is twenty-five times as great as the daily dose (2 mg.) which Legge regards as the minimum which may cause chronic plumbism if inhaled daily over a course of years. It was also reported that the approximate quantity of lead inhaled daily by an oxyacetylene cutter in ship scrapping is nearly fourteen times greater than that inhaled by a lead burner working on metallic lead alone. The amount of lead in the fume varied in these tests with the thickness of the paint, so that from a deck plate of a light craft the amount of lead was found to be only half that from the armor decking of a battleship.

It may be of interest at this point to allude to a statement of Hutton (3) that "lead poisoning is the most important industrial poisoning, there being upward of 150 different trades in which workers are exposed." This author, however, does not take cognizance of plumbism in ship scrapping operations. This occupational condition is of comparatively recent development and presents a new problem in industrial hygiene.

The scrapping operations at the Philadelphia Navy Yard began Dec. 15, 1923, and were practically completed Feb. 15, 1925. Lead poisoning, however, was not made a compensable disability by federal statute until June 6, 1924. Prior to that date, therefore, there was no opportunity to undertake a systematic study of this disability. The period of the present study runs between June 6, 1924, and Feb. 15, 1925, slightly over eight months.

## General Statistics

### *Incidence of Plumbism*

The incidence of plumbism for the period under consideration is shown in Table 1. The total number of men employed for the entire period was 221. The number of men employed per month varied from 90 in October, 1924, to 54 in January, 1925; the monthly average for the entire period was 73. The total number of admissions per month varied from 1 in June to 23 in October, 1924; the average was 10. First recurrences varied from none in June and July, 1924, to 7 in January, 1925; an average of 2.7. Second recurrences varied from none in June, July, August, and September to 2 in December, 1924, and January, 1925. One third recurrence only was reported, in December, 1924. In other words, 22 first recurrences occurred among 83 admissions, or 26.5 per cent.; second recurrences were 7.2 per cent. of the first admissions; and third recurrences, 1.2 per cent. The maximum number of sick days per case was 69; the minimum was 3; the average, 20. The total number of working days lost as a result of plumbism was 2,105, or an average of 253.6 per month.

It will be noted in Table 1 that the monthly rate of cases per hundred varied in the full months from 10.9 in August to 31.4 in January. There were no admissions in February and only 1.9 per hundred in June. The annual rate of cases per hundred was 72.5.

*In Relation to Age.*—The incidence of plumbism in relation to age is shown in Table 2. The average age of the 221 men employed during the entire pe-

riod of ship scrapping was 28 years; the maximum was 55, the minimum 19; the present series were comparatively young.

TABLE 1.—GENERAL STATISTICS SHOWING INCIDENCE OF PLUMBISM AMONG 221 MEN EMPLOYED IN SHIP SCRAPPING, FOR THE PERIOD JUNE 6, 1924, TO FEB. 15, 1925

| MONTH | MAN POWER EMPLOYED | FIRST ADMISSIONS | FIRST RECURRENCES | SECOND RECURRENCES | THIRD RECURRENCES | TOTAL CASES | TOTAL MAN DAYS | DAYS LOST FROM SICKNESS | | MONTHLY RATE PER HUNDRED[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Number | Percentages | |
| June [2] | 64.8 | 1 | 0 | 0 | 0 | 1 | 1,361 | 5 | 0.4 | 1.9 |
| July | 84.2 | 15 | 0 | 0 | 0 | 15 | 2,021 | 193 | 9.5 | 17.8 |
| Aug | 82.4 | 6 | 3 | 0 | 0 | 9 | 1,923 | 132 | 6.8 | 10.9 |
| Sept. | 83.2 | 13 | 2 | 0 | 0 | 15 | 1,923 | 364 | 18.9 | 18.0 |
| Oct. | 90.5 | 23 | 2 | 1 | 0 | 26 | 2,352 | 281 | 11.9 | 28.7 |
| Nov. | 71.6 | 8 | 5 | 1 | 0 | 14 | 1,647 | 406 | 24.6 | 19.6 |
| Dec. | 67.3 | 9 | 3 | 2 | 1 | 15 | 1,683 | 297 | 17.6 | 22.3 |
| Jan. | 54.2 | 8 | 7 | 2 | 0 | 17 | 814 | 288 | 35.3 | 31.4 |
| Feb.[3] | 19.3 | 0 | 0 | 0 | 0 | 0 | 232 | 139 | 59.9 | 0.0 |
| Totals | 617.5 | 83 | 22 | 6 | 1 | 112 | 13,956 | 2,105 | .... | .... |

[1] Rate per hundred for 8.3 months = 49.8; annual rate per hundred = 72.5.
[2] Beginning June 6, 1924.
[3] Ending Feb. 15, 1925.

194, or 87.8 per cent., were between 21 and 30; only five were over 50; eighty-nine, or 40.3 per cent., were from 31 to 40. It will be noted that fifty-two, or 62.7 per cent., of the cases of plumbism were in men between 21 and 30 years of age; twenty-one, or 25.3 per cent., in men between 31 and 40; and only eight, or 9.6 per cent., in men over 41. The average age of the men with plumbism was 28.6 years. Legge (4) states that of 171 cases of plumbism in oxyacetylene burners reported from British scrapping operations forty-seven were in men under 25 years of age; 104 in those under 30; and sixty-seven in those over 30. The age incidence appeared to correspond in general with the age distribution of these workers. Most of the men in

*In Relation to Exposure Prior to the Present Job.*—Seventeen of the eighty-three cases of plumbism reported a varying degree of previous exposure at other ship scrapping plants. Nine of these came directly from such work to the present job; the time of the former job varied from one week to two years before the present work. Only two men gave a distinct history of plumbism in this former work, the attacks having been of acute type but of short duration. None reported symptoms or exhibited signs when examined for employment here.

*In Relation to Exposure in Present Job before Admission.*—For the eighty-three first admissions the longest period of exposure to lead fumes was 13.2 months; the shortest, 7 days; the aver-

age of all cases, 2.4 months. Twelve men had worked less than one month; twelve more between one and two months; sixteen between two and three months. Of the twenty-two first recurrences (see Table 1) the shortest interval elapsing since the first attack was 4 days; the longest, 3.8 months; the average, 1.8 months (54 days). Of the six second recurrences (see Table 1) the shortest period since the first was 2 days; the longest, 2.9 months; the average, 31 days.

TABLE 2.—INCIDENCE OF PLUMBISM IN RELATION TO AGE OF MEN ADMITTED TO SICK LIST

| YEARS OF AGE | FIRST ADMISSIONS | |
|---|---|---|
| | Number | Percentages |
| Under 21 | 2 | 2.4 |
| 21 to 30 | 52 | 62.7 |
| 31 to 40 | 21 | 25.3 |
| 41 to 50 | 8 | 9.6 |
| Over 50 | 0 | 0.0 |
| Total | 83 | 100.0 |

These findings are of great interest in comparison with the 171 cases collected by Legge in Great Britain already referred to. Of the 171 cases seventy, or 40.9 per cent., were reported within a year of beginning the burning of paint covered metal; twenty of these, or 11.6 per cent., occurred in less than three months; reported recurrences in the last four years numbered sixteen.

## Clinical Findings

### *Basophilia*

The data for basophilia are presented in Tables 3 and 4. All of the blood examinations were made at the clinical laboratory of the Naval Hospital, Philadelphia. Examinations of smears for basophilia were made on admission in all plumbism cases, Wright's stain being employed. It will be noted in Table 3 that the degree of stippling was reported in the first sixty-six cases as of slight, moderate, or marked grade. In the succeeding forty-two cases it was recorded by a scoring system proposed by McCord, Minster, and Rehm (5) as follows:

| | |
|---|---|
| + | Few cells containing basophilic aggregations on entire slide. |
| ++ | Cells containing basophilic aggregations on average of 1 in every 5 fields. |
| +++ | Cells containing basophilic aggregations in approximately every field. |
| ++++ | Four cells containing basophilic aggregations in approximately every field. |
| ++++++ | Six cells containing basophilic aggregations in approximately every field. |
| ++++++++++ | Ten or more cells containing basophilic aggregations in approximately every field. |

This scale proved to be of considerable value for comparative scoring.

*In the Active Cases of Plumbism.*—Negative examinations (see Table 3) resulted in only 12.9 per cent. of the entire series. Of the first sixty-six cases 31.8 per cent. showed marked stippling; of the last forty-two 28.6 per cent. showed a basophilia of 3 plus, and 11.9 per cent. showed 4 plus. Basophilia is therefore a pronounced feature in the present series of cases. In the first series, 37.9 per cent. were of slight grade, and in the second series

TABLE 3.—RESULTS OF BLOOD EXAMINATIONS MADE FOR BASOPHILIA, RED CELLS, AND HEMOGLOBIN IN 108, 70, AND 69 OF THE 112 CASES OF PLUMBISM, RESPECTIVELY

| FINDINGS | NUMBER OF CASES | PERCENTAGES |
|---|---|---|
| *Examinations for Basophilia* | | |
| Without scale: | | |
| Negative | 9 | 13.6 |
| Slight grade | 25 | 37.9 |
| Moderate grade | 11 | 16.7 |
| Marked grade | 21 | 31.8 |
| Total | 66 | 100.0 |
| With scale: | | |
| Negative | 5 | 11.9 |
| 1 plus | 10 | 23.8 |
| 2 plus | 9 | 21.4 |
| 3 plus | 12 | 28.6 |
| 4 plus | 5 | 11.9 |
| 6 plus | 1 | 2.4 |
| Total | 42 | 100.0 |
| Total cases negative for basophilia | 14 | 12.9 |
| *Examinations for Red Blood Cell Counts* | | |
| *per c. mm.* | | |
| 5,000,000 to 5,500,000 | 6 | 8.6 |
| 4,500,000 to 5,000,000 | 14 | 20.0 |
| 4,000,000 to 4,500,000 | 18 | 25.7 |
| 3,500,000 to 4,000,000 | 25 | 35.7 |
| 3,000,000 to 3,500,000 | 6 | 8.6 |
| 2,500,000 to 3,000,000 | 0 | 0.0 |
| 2,000,000 to 2,500,000 | 1 | 1.4 |
| Total | 70 | 100.0 |
| *Examinations for Hemoglobin* | | |
| % | | |
| 90 to 100 | 2 | 2.9 |
| 85 to 90 | 9 | 13.0 |
| 80 to 85 | 8 | 11.6 |
| 75 to 80 | 17 | 24.7 |
| 70 to 75 | 11 | 15.9 |
| 65 to 70 | 6 | 8.7 |
| 60 to 65 | 7 | 10.1 |
| 55 to 60 | 6 | 8.7 |
| 50 to 55 | 2 | 2.9 |
| 45 to 50 | 1 | 1.5 |
| Total | 69 | 100.0 |

23.8 per cent. were reported as 1 plus.

*In Cases Unassociated with Symptoms of Plumbism.*—Of forty-two oxy-acetylene burners with daily exposure to lead fumes who were examined for basophilia in November, 1924, and in whom no symptoms of plumbism were alleged, 35.7 per cent. were negative for basophilia (see Table 4); 28.6 per cent. were 1 plus; 11.9 per cent. were 2 plus; 21.4 per cent. were 3 plus; and 2.4 per cent. were 4 plus. Thus 64.3 per cent. showed evidence of lead absorption resulting in stippling.

*In Normal Persons.*—Basophilia is not in any case a disabling condition in itself (Oliver (6), Sellers (7), Teleky (8)), and it has occasionally been reported in apparently normal individuals as is testified by Otto Naegeli (9), who cites Trautmann as finding it in 21 per cent. of clinically healthy persons examined (9, p. 630).

McCord, Minster, and Rehm (5, p. 1761) subjected the blood of eighteen normal persons to examination. These workers, however, employ a technic designated as the basophilic aggregation test which leads to a

massing in young red cells of basophilic material which cannot be demonstrated by staining with Wright's stain. Such stippled cells as appear after Wright's method are preformed in the blood. The stippled cells seen in the basophilic aggregation test are not preformed but are entirely due to the artificial aggregation of the evenly distributed basophilic substance in the young cells. The special method employed is described in detail in their paper. Admitting that the number of individuals is small, they report the percentage showing the basophil granules as 66 per cent.—thus coinciding with Schwarz' figure. However, in no case did the basophilia exceed 2 plus of the scale; in fact the majority of positives were recorded as 1 plus. Under their rating scale they place the upper limit for normal persons as 2 plus.

TABLE 4.—RESULTS OF BLOOD EXAMINATIONS MADE IN NOVEMBER, 1924, FOR BASOPHILIA IN 42 OF 62 MEN EXPOSED TO LEAD FUMES BUT HAVING NO SYMPTOMS OF PLUMBISM

| BASOPHILIA | NUMBER OF CASES | PERCENTAGES |
|---|---|---|
| Negative | 15 | 35.7 |
| 1 plus | 12 | 28.6 |
| 2 plus | 5 | 11.9 |
| 3 plus | 9 | 21.4 |
| 4 plus | 1 | 2.4 |
| 6 plus | 0 | 0.0 |
| Total | 42 | 100.0 |

As a series of controls for the writer's findings in 108 cases of plumbism, blood smears were taken from fifty-five apparently normal individuals and examined for basophilia by Wright's stain. This group comprised thirty-one Hospital corpsmen and twenty-four Navy Yard workmen. The entire slide was carefully examined twice in each instance. No evidence of stippled cells in any specimen was found. These results of course are not comparable with those reported by McCord, Minster, and Rehm, as the basophilic aggregation test was not used. They are, however, of interest as controls in showing the absence of preformed stippled cells.

*In Comparison with Other Groups of Cases.*—Of interest in this connection is a report received Dec. 29, 1924, by the author in the form of a personal communication from Mr. C. E. Sheibley (10), chief engineer and superintendent of the Industrial Accident Commission, Department of Safety, state of California, relative to a recent clinical study of ninety cases of plumbism resulting from the use of the oxy-acetylene cutting torch in scrapping at the plant of the General Metals Supply Company. Basophilia was found in only three cases, in sharp contrast to the data collected by the writer in his present series. This appears remarkable in view of the similar industrial conditions imposed.

There is much conflicting evidence as to the constancy of basophilia in lead poisoning. Linenthal (11) reports that in nearly 50 per cent. of a large number of cases of plumbism in the outpatient department of the Massachusetts General Hospital basophilic granules were absent in the red cells.

Harris (12), in a study of 103 active cases, noted the absence of basophilia in 88 per cent. He obtained the fol-

lowing results: Of 103 active cases, 13, or a trifle more than 12 per cent., showed basophilia; of 19 latent cases, 5, or barely 21 per cent., were reported positive; of 27 borderline cases, only 4 showed stippling; and of 60 negative cases, only 1 was positive. It would therefore appear, on the basis of this study, that this sign, like the lead line, is of limited practical value.

Russell (13) found that twenty-seven out of 100 persons in a compensation status for plumbism had no basophilia. Lutoslawsky (14) found it absent in 15.9 per cent. of 107 patients suffering with chronic plumbism. P. Schmidt (15) found no basophilia in 72.9 per cent. of 546 lead workers. Teleky (8) found no basophilia in 31.6 per cent. of seventy-nine patients showing blue line and cachexia and subjective symptoms from exposure to lead. Oliver (6, p. 126) reports absence of basophilia in 75 per cent. of his cases of plumbism. These findings are supported by expressions of opinion by Hayhurst (16), Rambousek (17), Rand (18), Biondi (19), Shie (20), and Meyer and Speroni (21), all of whom state that basophilia is certainly not invariably present in lead poisoning. Meyer and Speroni found basophilia present one day, absent another. On the other hand Schnitter (22) reports that all of his cases of plumbism showed stippling and attributes the alleged absence in cases reported by others to the fact that fine stippling is obscured by the counterstain used to bring it out.

Others hold that basophilia, while of diagnostic value in conjunction with symptoms of poisoning, is not of itself conclusive. Oliver says that he would hardly recommend suspension from work for this reason. Sellers (7) found that in twenty-one lead workers the proportion of stippled cells to normal corpuscles had no relation to the incidence of actual poisoning among the cases. Hayhurst considers basophilia of no significance unless it exists to the extent of 1 in every 100 red cells (16, p. 380).

McCord, Minster, and Rehm (5, pp. 1762–1763) conclude from their experience that "on a quantitative basis, clinical cases of lead poisoning regularly exhibit a high basophilic aggregation content of the blood." In fact they point out that the majority of workers exposed to lead quickly come to have a higher degree of basophilia than is found among normal persons and that this indicates a preclinical plumbism. If, in the routine examination of these lead workers, it is found that stippling is increasing, such workers in the absence of other disease should at least be placed on lead eliminative treatment. They recommend this if the rating is 6 plus or higher. If clinical signs of plumbism are suggested, treatment is begun at a rating of 4 plus.

*Diagnostic Value.*—Schoenfeld (23) has pointed out that the relative dangers of different lead occupations may be assessed by the incidence of basophilia among the workers. He believes also that the presence of basophilia is of marked diagnostic value. As opposed to this view Teleky (8) and Rambousek (17) in common with English and American authorities insist that basophilia is of only supplementary value in conjunction with other signs and symptoms (3, p. 37).

*Discussion.*—Certainly if the evidence from various sources is accepted,

there is abundant proof that lead poisoning can exist without basophilia, and basophilia without plumbism and even without lead absorption. Schnitter (22) considers that workers with more than 100 stippled cells per million should not be allowed to work with lead and that those with 500 are definitely ill. Schoenfeld (23) considers that 100 warrant a positive diagnosis, that thirty per million are indicative of lead absorption even without symptoms, and that 300 warrant suspension from work. Schmidt ((15) as cited in (6, p. 127)) thinks a diagnosis of plumbism is warranted on the basis of 100 basophilic cells per million.

### *Red Blood Cell Count and Hemoglobin*

*Red Cell Count.*—Red cell counts were made in seventy cases (see Table 3). In analyzing these data with reference to the development of anemia the question arises as to what constitute the lower normal limits for both the red count and the hemoglobin. These are set somewhat arbitrarily as 4,000,000 and 80 per cent., respectively. The lowest red cell count found in this series was 2,420,000; the average was 4,178,000.

*Hemoglobin.*—Hemoglobin was estimated in sixty-nine cases, the Tallqvist method being employed. Seventy-two per cent. of the data are below 80 per cent. in hemoglobin; 47.8 per cent. are below 75; 31.8 per cent. below 70; 13 per cent. below 60; the lowest percentage of hemoglobin is 50; the average percentage is 76.1.

*Discussion.*—Anemia is one of the commonest conditions noted in the reports of chronic lead poisoning cases, but there are virtually no data in the literature bearing on acute poisoning of which the present series is a type. Gilman Thompson (24) states that in chronic plumbism the red cells are not often found to fall below 4,000,000 and that the hemoglobin falls to 75 or 85 per cent.—sometimes to 50 per cent. Shie (20) questions whether the characteristic pallor of plumbism in chronic plumbism is due to anemia at all and believes the latter is present less frequently than is commonly supposed. In most of his cases red blood counts were only slightly below normal. His hemoglobin percentages varied considerably but on the whole were not affected by plumbism; none were found below 65, the majority being between 80 and 100 per cent. Harris (12) found a marked secondary anemia in 53 per cent. of his chronic cases. In twenty-seven of these cases the hemoglobin percentage was less than 70. Among his nineteen latent cases, fourteen patients were found to be anemic; among the twenty-seven borderline cases, twenty-four; and among the sixty negative cases, forty-seven.

In the ninety cases of plumbism occurring in ship scrapping reported by the Industrial Accident Commission of California (10), the average red blood count was 4,530,000. With reference to hemoglobin, 32 per cent. of the data were below 80; 15.5 per cent. below 75; two cases between 60 and 70. The findings in the author's series of 112 cases are in marked contrast to these figures in that anemia is a much more pronounced finding.

### *Blood Pressure*

It may be of interest at the outset to consider certain literature bearing on

this aspect of lead poisoning. According to the observations of Legge and Goadby (25), the blood pressure of lead workers tends to be high. In an average of 100 workers who had had years of exposure to lead but none of whom showed signs of actual poisoning, the highest pressure was 178, the lowest 115, the mean 150. Collis (26) found the average among 141 smelters to be 148.2, and among thirty-eight white lead workers, 156.5.

Oliver (6, p. 191) states that there is an opinion that work in lead tends to raise arterial pressure. In a series of men working in white lead in Newcastle he found that the average blood pressure was 131.4, the highest 180. His impression is that during the early years of employment in a lead factory the work does not affect the blood pressure to any marked degree, but that there is hardly any doubt that, as time goes on and the function of the excretory organs is interfered with, the blood pressure rises; also that structural changes are induced in the arteries, for only by this means can be explained the large number of deaths from cerebral hemorrhage in persons who have worked in lead; and, finally, that the duration of work and of the particular habits must materially influence this question of blood pressure.

Harris (12, p. 143) reports evidences of arteriosclerosis in a total of sixty-three painters representing 26 per cent. of those in whom blood pressure observations were made. Thirty-six of these persons who had a systolic pressure of 150 or more were cases of active plumbism. Of active and latent cases, forty-four, or slightly more than 39 per cent. of those in whom blood pressure records were made, showed a systolic pressure of 140 or over. The remaining sixty-seven painters, or 61 per cent. of the active and latent cases, had a systolic pressure of 130 or less. Harris emphasizes the fact that "the action of lead is a slow one, and it is very likely that this low blood pressure is coincident with that period during which fibrotic changes which lead to sclerosis of the vascular system are slowly making headway."

The data for blood pressure in the present study are given in Table 5.

*In the Active Cases of Plumbism.*—Reference to Table 5 indicates that in the present series of 112 cases of which 108 were examined for blood pressure only six, or 5.5 per cent. of the cases examined, exceeded a systolic pressure of 150; the maximum for the series being 175 systolic and 79 diastolic, the minimum 98 and 70, the average 122 and 74. In other words 94.5 per cent. of all systolic readings were below 150, 90.8 per cent. below 145, and 66.7 per cent. below 125. The general conclusion is drawn that the type of plumbism here discussed did not exert any definite cardiovascular effects as shown by blood pressure.

*In Cases Unassociated with Symptoms of Plumbism.*—As part of a general examination of gas welders for evidences of plumbism, seventy-one men were inspected in September and sixty-two men in November, 1924, respectively. For the seventy-one men inspected in September, the maximum systolic pressure was 166, the minimum 105, the average 127. In the November inspection of sixty-two men, the maximum systolic pressure was 158, the minimum 110, the average 128. Six reached 150 systolic or

over in September and November combined. There was, therefore, no definite tendency to hypertension shown in the workers without symptoms of lead poisoning.

TABLE 5.—DATA FOR SYSTOLIC BLOOD PRESSURE EXAMINATIONS MADE IN 108 OF THE 112 CASES OF PLUMBISM

| SYSTOLIC BLOOD PRESSURE | NUMBER OF CASES | PERCENTAGES |
|---|---|---|
| 170 to 175 | 1 | 0.9 |
| 165 to 170 | 0 | 0.0 |
| 160 to 165 | 1 | 0.9 |
| 155 to 160 | 1 | 0.9 |
| 150 to 155 | 3 | 2.8 |
| 145 to 150 | 4 | 3.7 |
| 135 to 145 | 7 | 6.5 |
| 125 to 135 | 19 | 17.6 |
| 115 to 125 | 52 | 48.1 |
| 105 to 115 | 17 | 15.8 |
| 98 to 105 | 3 | 2.8 |
| Total | 108 | 100.0 |

| | Systolic | Diastolic |
|---|---|---|
| Maximum reading | 175 | 79 |
| Minimum reading | 98 | 70 |
| Average reading | 122 | 74 |

*Arteriosclerosis.*—There was no indication of fibrosis of superficial arteries; the radial and temporal arteries not being definitely palpable in any of these cases. The eyegrounds were not examined for signs of vascular changes. Due allowance would, of course, have been made for cardiovascular signs which might be connected with arterial degeneration due to these causes.

In the series of cases reported to the Industrial Accident Commission of California (10) there was no development of cardiovascular pathology that could be attributed to lead. Occasional albuminuria of very slight grade and cylindruria were noted. The phenolsulphonephthalein renal function test yielded normal findings in these cases. No indication of actual organic renal impairment was found.

*Blue Line on the Gums*

Certain points in the literature will first be briefly referred to. Oliver (6, p. 133) stresses the distinction which must be drawn between a "true" and a "false" blue line; the latter being more or less readily removed by the toothbrush—and therefore particularly associated with carious teeth and gingivitis. According to Oliver: "The true Burtonian or characteristically blue line of plumbism is not so readily removed, for it is due to a deposit of particles of lead sulphide inside the cells of the deeper layers of the gums." He also considers (6, p. 136) that the lead line is not in itself a proof of lead poisoning but rather an evidence of lead absorption and, together with the other symptoms, a valuable diagnostic sign. Therefore a blue line on the gums by itself indicates rather the presence of lead than lead poisoning, but as a danger signal and as affording confirmation of the exact etiology and correlated with other symptoms it is a very valuable sign.

Rambousek (17) expresses substantially a similar view but points out at the same time that mercury, iron, and silver produce a very similar line and that workers in charcoal may also show a superficially similar phenomenon. W. H. Rand (18, p. 386) reports the blue line as "the most constant of the symptoms of plumbism,"

but neither inevitable in nor peculiar to it, since in some cases it is lacking. Linenthal (11) reports instances of unquestioned plumbism where there was no sign of the blue line and is of the opinion that it is "extremely rare when the gums are in a healthy condition and when the teeth are well cared for." Harris (12, p. 141) found the lead line in less than 14 per cent. of the active cases among 400 painters, and states that in his own opinion the blue line is infrequently encountered in those whose teeth are kept clean.

Hayhurst (16, p. 381) points out that while the lead line is a sign of lead absorption and warrants a tentative diagnosis it does not in itself prove lead poisoning. Shie (20) reports that 90 per cent. of all his patients had a well-marked lead line, not invariably associated with bad gums and teeth. He considers all these to be potential cases of plumbism, since the lead line proves absorption of lead.

*In the Active Cases of Plumbism.*—In Table 6 of the present study it will be seen that of the 112 cases 51.8 per cent. yielded positive findings; it will also be noted that the lead line was slight in 51.7 per cent. of the positive cases. In the present series, therefore, the lead line was of only moderate diagnostic significance, only a little over half of the cases showing this sign. Most of the patients both with and without the blue line had very bad gums and teeth, pyorrhea and gingivitis being marked; in fact the great majority admitted that the toothbrush was employed rarely if at all. A definite lead line was observed in only five persons who had excellent teeth and gums.

*In Cases Unassociated with Symptoms of Plumbism.*—In September, 1924, seventy-one burners were examined; seven, or 9.8 per cent., exhibited a definite blue line. In November, 1924, sixty-two men were inspected,

TABLE 6.—RESULTS OF EXAMINATIONS FOR BLUE LINE IN THE 112 CASES OF PLUMBISM

| BLUE LINE | NUMBER OF CASES | PERCENTAGES |
|---|---|---|
| Negative | 54 | 48.2 |
| Slight grade | 30 | 26.8 |
| Moderate grade | 16 | 14.3 |
| Marked grade | 12 | 10.7 |
| Total | 112 | 100.0 |
| Total positive findings | 58 | 51.8 |

and five cases of blue line, or 8.1 per cent., found. These were undoubted cases of lead absorption without symptoms.

*Discussion.*—The writer is strongly of the opinion that the lead line may or may not be present in well-defined plumbism and that when observed it does not mean that the person has lead poisoning. Certain persons were observed with well-marked lead lines who were apparently free from symptoms of any character. These are all cases of lead absorption, however, and if the balance between absorption and elimination were interfered with the men would probably develop active symptoms. The same consideration applies to lead in the urine and to basophilia without symptoms.

### *Urinary Findings*

#### *Albumin, Sugar, Specific Gravity*

Of the 112 admissions, seventy-eight were submitted to urinary ex-

amination for albumin and sugar and sixty-seven for specific gravity (see Table 7). A faint trace of albumin was reported in four instances but these results were not correlated with

TABLE 7.—RESULTS OF EXAMINATIONS OF THE URINE FOR ALBUMIN, SUGAR, AND CASTS, AND FOR SPECIFIC GRAVITY IN THE 112 CASES OF PLUMBISM

| FINDINGS | NUMBER OF CASES |
|---|---|
| Examined for albumin and sugar ... | 78 |
| Positive for albumin ..... | 4 |
| Positive for sugar ..... | 0 |
| Examined for specific gravity ..... | 67 |
| Specific gravity from 1.010 to 1.015. | 15 |
| Specific gravity from 1.015 to 1.032. | 52 |
| Given microscopic examination..... | 40 |
| Positive for casts ..... | 2 |

low specific gravity, casts, or elevated blood pressure—in other words, they were indicative only of simple albuminuria and not of chronic nephritis. Sugar was uniformly absent. The lowest specific gravity recorded as 1.010 was found in one case only; the highest specific gravity was 1.032; the average, 1.020. The case with the lowest gravity was unassociated with any sign of renal impairment. Gravity fixation or renal function tests were therefore not indicated. All data may be interpreted under the circumstances as falling within normal limits.

*Microscopic*

Forty microscopic examinations were carried out at the clinical laboratory of the Naval Hospital. Two were reported as containing a few hyaline casts. The other associated findings of these specimens as well as the clinical symptoms failed to indicate any signs of renal pathology. The blood pressures were within normal limits.

*Pathologic*

Oliver ((6) as cited in (3, p. 27)) has found in chronic plumbism that there may be atrophy of the connective tissue and glomeruli of the kidney with hyaline degeneration of the vessels—in general the lesions of the kidney are those of chronic interstitial nephritis. It appears to be the consensus of opinion that such pathology is the result of long and protracted exposure to lead over a period of years. On the other hand, where a lead worker dies from acute plumbism after being employed only a few weeks or months, there may be an acute parenchymatous nephritis (3, p. 27). In the author's series of cases the former lesions would hardly be looked for in view of the relatively short exposure and the acute type of the disability. There were no laboratory signs of any type of lesion. The generally negative character of the urinary findings is in line with what may be anticipated. The lack of significant changes in blood pressure discussed under that heading is in harmony with the lack of pathologic changes in the urine.

*Lead*

The quantitative analyses for lead in the urine were carried out by the chief chemist of the Supply Department of the Navy Yard. The recent method of Fairhall (27) of the Harvard Medical School, which represents a

striking advance in quantitative delicacy, was employed. This greatly simplifies and shortens the older technic with a marked refinement in accuracy.

The quantity of lead excreted in the urine of patients suffering from plumbism is extremely small. As small a quantity as 0.05 mg. per 2,000 c.c. of urine may be satisfactorily quantitated. Fairhall reports the analyses of the urines of thirteen patients suffering from lead poisoning; the volume of urine varying from 3,075 to 15,000 c.c. No lead was found in two of his cases; in the remainder the amount of lead varied from 0.009 to 0.154 mg. per liter.

*In the Active Cases of Plumbism.*—Urinary specimens were analyzed from twenty-six patients, or 23.2 per cent. of the 112 cases. Twenty-four to forty-eight-hour samples were furnished. All data are calculated on the basis of 2,000 c.c. for comparison and are recorded in Table 8. Lead was found in all with one exception. The amount varied from 0.05 mg. to 2.15 mg. per 2,000 c.c.; the average amount was 0.47 mg. These results emphasize the extremely small amounts of lead that may be found in the urine in acute cases of this type.

*In Cases Unassociated with Symptoms of Plumbism.*—Samples were collected from J. T., A. W. A., and G. W. S., these men being selected at random. They had worked continuously for 13, 10.5, and 10.5 months, respectively; they had never been admitted and were symptomatically normal during the entire period. Physical examination was negative except for a marked blue line in the case of J. T. All three showed a 1 plus degree of basophilia; red counts and hemoglobin were normal. Lead was present in all three urines, as recorded in Table 8.

*Discussion.*—The presence of lead in the urine is closely analogous to basophilia and to the blue line in rela-

TABLE 8.—RESULTS OF QUANTITATIVE EXAMINATIONS FOR LEAD IN THE URINE

| NUMBER OF SPECIMEN | SUBJECT | VOLUME OF URINE | LEAD FOUND | LEAD PER 2,000 C.C. |
|---|---|---|---|---|
| *In Twenty-Six Cases of Active Plumbism* | | | | |
| | | *c.c.* | *mg.* | *mg.* |
| 1 | C. J. C. | 1700 | 0.14 | 0.164 |
| 2 | W. M. | 1740 | 0.32 | 0.367 |
| 3 | D. K. | 1650 | 0.10 | 0.121 |
| 4 | R. K. | 2130 | 0.40 | 0.375 |
| 5 | J. G. B. | 750 | 0.10 | 0.266 |
| 6 | F. B. | 950 | 0.09 | 0.189 |
| 7 | N. C. S. | 1360 | 0.09 | 0.132 |
| 8 | T. H. A. | 440 | 0.04 | 0.181 |
| 9 | H. A. W. | 970 | 0.07 | 0.144 |
| 10 | D. R. | 1310 | 0.07 | 0.106 |
| 11 | D. K. | 1960 | 0.06 | 0.061 |
| 12 | M. V. | 1950 | 0.05 | 0.051 |
| 13 | J. J. G. | 1070 | 0.27 | 0.504 |
| 14 | R. G. | 2030 | 0.16 | 0.157 |
| 15 | H. K. | 630 | 0.17 | 0.539 |
| 16 | F. M. M. | 1430 | 0.36 | 0.503 |
| 17 | J. I. K. | 260 | 0.28 | 2.153 |
| 18 | C. C. | 1010 | 0.23 | 0.455 |
| 19 | H. C. | 750 | 0.10 | 0.266 |
| 20 | H. D. | 1050 | 0.68 | 1.295 |
| 21 | L. S. | 1920 | 1.69 | 1.760 |
| 22 | R. R. | 1380 | 0.33 | 0.478 |
| 23 | O. D. | 1500 | 0.37 | 0.493 |
| 24 | O. J. J. | 1500 | 0.68 | 0.906 |
| 25 | F. | 1500 | 0.46 | 0.613 |
| 26 | A. W. B. | 1200 | 0.00 | 0.000 |
| *In Three Men Exposed to Lead but Having No Symptoms of Plumbism* | | | | |
| | | *c.c.* | *mg.* | *mg.* |
| 27 | J. T. | 1890 | 0.07 | 0.074 |
| 28 | A. W. A. | 1910 | 0.29 | 0.303 |
| 29 | G. W. S. | 1870 | 0.19 | 0.203 |

tion to diagnosis. It indicates lead absorption but not necessarily lead poisoning. Such cases, however, should be considered as close to the borderline status. A disturbance in balance of absorption and elimination may at any time precipitate active symptoms of plumbism. Lead in the urine, however, is undisputed proof of absorption, which is not true in the same positive sense for basophilia and for the blue line.

## Path of Absorption of Lead in Oxyacetylene Cutting

### *Examination of the Lead Fume*

Samples of the lead fume were collected on microscopic slides on which it readily condensed and photomicrographs taken, one of which is given in Figure 3.

The fume is seen to consist of enormous numbers of translucent colorless particles being estimated at about one-half micron for the average diameter, or one-fifteenth of the diameter of a red blood cell. The composition is lead or lead coated with a film of lead oxide, the lead being demonstrated by the microchemical test of Fairhall (28). The particles are so dense as to be almost touching; they are irregular in form and apparently more flaky than globular. Material of such extreme fineness is readily adapted to rapid absorption through the pulmonary alveoli.

### *Absorption from the Gastro-Intestinal Tract versus the Respiratory Tract*

The relative amount and rate of absorption of lead from the gastro-intestinal and respiratory tracts have been the subject of much experimentation and are important factors in the etiology of the disease. Authorities differ as to whether lead dust when breathed through the nose and mouth more commonly reaches the stomach or the lungs. Oliver (6, pp. 116–117) in

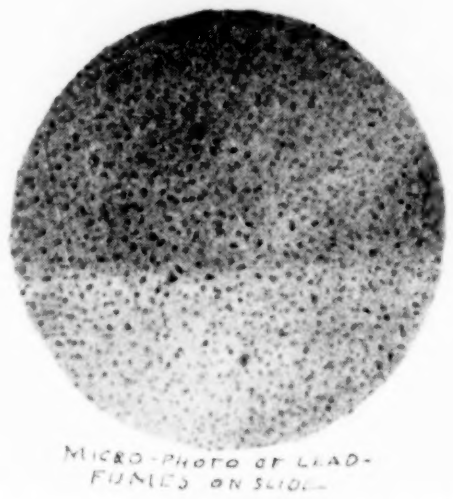


Fig. 3.—Photomicrograph of lead fume. × 266.

discussing the question of the inhalation of lead dust, while acknowledging that some of the fine particles are carried into the lungs, considers that the amount must be small. He holds that the bulk of the lead dust breathed is caught in the mouth and throat, is there dissolved in the saliva, swallowed, and conveyed to the alimentary canal.

On the other hand, in the feeding and inhalation experiments of Legge and Goadby (25, pp. 86, 98), with animals exposed to inhalation of lead dust plumbism developed far more rapidly than in animals which were being fed at least ten times as much lead by mouth. Legge and Goadby concluded that apparently small quantities of lead reaching the lungs are much more apt to produce poisoning than larger quantities reaching the stomach. From the standpoint of prophylaxis as a measure of industrial hygiene it is im-

material whether the dust is more apt to reach the lungs or the alimentary canal, as it is agreed that the chief source of poisoning in industry is the breathing of dust and it is against this that prevention should be mainly directed.

During the past few years a group of research workers at the Medical School of Harvard University have been concentrating on various aspects of plumbism. Their investigations mark important advances in pathology, pathogenesis, and treatment. Two striking contributions to the subject under discussion were made recently by Minot (29) (30) (31) and Blumgart (32) of this group. Experimenting with cats and employing lead acetate solution, Minot found that much of the lead entering the gastro-intestinal tract is not absorbed but either is excreted directly or is caught by the liver and then eliminated; very large doses, 50 mg. of lead per kilogram of body weight given orally on alternate days, produced poisoning in a cat within a few weeks (29, p. 130). Absorption from the respiratory tract, on the other hand, is very rapid and dangerous (30).

Blumgart, working in the same laboratory, found that within twenty-four hours a relatively large quantity of lead could be absorbed by the organism when the only path of entry was through the nose and mouth. In each experiment the esophagus of the cat was tied off and a cannula inserted into the trachea, through which the animal breathed, thus preventing all inhaled substances from entering the lungs or stomach. Lead carbonate dust was rapidly absorbed on spraying into the nostrils, as proved by postmortem analysis of the various organs of the body for lead. The possibility in industry of absorption of lead through the nasopharynx is thus opened up.

Injections of lead into the trachea (32) and into the lungs of animals prepared in this way (30) lead to similar results. As much may be absorbed from one injection into the respiratory tract in one day as from gastro-intestinal exposure for months. The rapidity of absorption was marked and was shown not only by the quantity absorbed but by the rapid appearance of the lead line and other characteristic symptoms. The reason for the great rapidity of absorption from the respiratory tract is that by this route lead enters directly into the general circulation instead of passing through the liver, as in gastro-intestinal absorption. It thus reaches the vulnerable tissues with far greater ease and rapidity.

From the foregoing considerations it would appear that the lead contained in the fumes from oxyacetylene cutting, particularly in view of the extreme fineness of the particles, would pass to the lungs to the practical exclusion of the gastro-intestinal route. Such rapid access to the general circulation makes clear the relatively rapid development and nature of the symptoms which characterized this entire group of cases.

## Symptomatology

It should be stated in connection with symptomatology that the compensation factor has introduced a certain difficulty in the handling of the patients. Undeniably there has been exaggeration of symptoms, either con-

sciously or unconsciously, by certain patients. Complaints have been alleged which on investigation have not been found to rest on a pathologic basis, and care has been exercised to exclude such cases from an actual diagnosis of plumbism, as far as has been possible. Certain individuals, for instance, have presented a self-made diagnosis of plumbism who on careful study were found to show no signs of lead absorption such as the blue line, definite changes in the blood picture, and lead in the urine.

### *Case Histories*

Four representative case histories which are typical of the forms encountered in this study will first be cited.

Case 1.—J. McA., severe type, was admitted at the Navy Yard July 10, 1924; he was 34 years of age; he had had no previous work at other ship scrapping plants. He was exposed to fumes for a period of fifty days. He has complained of constipation, of occasional slight griping pains about the umbilicus, and of loss of appetite for the past two weeks. He was suddenly seized with severe pain in the lower abdomen; this was accompanied by nausea and vomiting, headache, vertigo, and general weakness. The clinical findings were: a moderate blue line, marked basophilia, red count 3,500,000, hemoglobin 60 per cent. The urine showed a trace of albumin and a few hyaline casts; it was not examined for lead. Systolic blood pressure was 132, diastolic 78. The acute abdominal pain rapidly subsided, and there was no vomiting after the second day. The man returned to work under observation symptomatically well in thirteen days. The first recurrence was reported Aug. 28, 1924, with symptoms of the same type much less severe. He was transferred to the Hospital, and returned to work in sixty-nine days apparently recovered. He had a second recurrence Oct. 12, 1924.

Case 2.—J. J. K., moderately severe type, was admitted Sept. 2, 1924; he was 29 years of age; he had had no previous work at other ship scrapping plants. The present exposure was for six months and eight days. He has had persistent constipation for six weeks; cramp-like pain in the lower abdomen from time to time for ten days but not severe enough to incapacitate him. The pain suddenly became aggravated and he had four attacks of vomiting lasting over forty-eight hours. Other symptoms were metallic taste in the mouth; vertigo and weakness; a slight lead line; red count 4,000,000; hemoglobin 65 per cent.; slight basophilia. The urine was negative. Systolic blood pressure was 136, diastolic 70. The case was ambulatory throughout. The acute symptoms rapidly subsided. The patient returned to work in twenty-one days free from symptoms, and continued at this work for forty-six days, with no recurrence reported.

Case 3.—A. H. B., mild type, aged 24, was admitted Dec. 27, 1924; he had worked at oxyacetylene cutting at a ship scrapping plant for six months eighteen months ago; his present exposure was two months. He has complained of moderate constipation for one month; of tiring easily during the past ten days; and of slight griping pains about the navel which began four days ago. The pains suddenly increased December 26. There was nausea and vomiting at intervals for two days; no headache at any time; metallic taste. These symptoms had largely disappeared by the third day. Other symptoms were a marked blue line; basophilia 4 plus; red count 4,000,000; hemoglobin 60 per cent. The urine was negative for albumin and casts; specific gravity was normal; lead in the urine was 0.54 mg. per 2,000 c.c. The dynamometer reading for the right hand was 170; for the left, 166. The man was discharged to work, symptomatically well in fifteen days. No recurrence has been reported.

Case 4.—H. D., anemic type, aged 41, was admitted Nov. 15, 1924; he had had no previous exposure at other ship scrapping plants; his present exposure at this Yard was one month and twenty-seven days. He had had constipation of mild degree for the past month; for the past two weeks he

has been conscious of tiring easily and of palpitation; he has experienced discomfort rather than pain in the lower abdomen; dull pain in the knees; metallic taste. Other symptoms were a just perceptible blue line; basophilia 6 plus; red count, November 5, 3,500,000; hemoglobin, same day, 62 per cent.; Dec. 2, 1924, 45 per cent. The urine was negative for albumin and casts but contained 1.295 mg. of lead per 2,000 c.c. The dynamometer reading for the right hand was 165; for the left, 158. Systolic blood pressure was 116, diastolic 65. The patient was transferred to the Hospital and discharged in forty-one days symptomatically well. He resigned from the Yard on discharge.

The great bulk of the cases correspond to the general clinical picture of Case 3. The cases may, however, be classified into three general groups:

1. Active or positive cases of plumbism: In these the clinical and laboratory findings are clear cut and sufficient on which to base a positive diagnosis.

2. Borderline cases: In these the clinical findings were only suggestive but the physical and laboratory signs of lead absorption were positive.

3. Latent or inactive cases: These were definitely asymptomatic, but undoubted signs of lead absorption were present such as basophilia, lead line, or lead in the urine. None of these cases were admitted but when discovered at inspections were placed under supervisory control and eliminative treatment.

### *Distribution of Symptoms*

Reference is made to Table 9, in which is given the distribution of symptoms in the 112 cases of active plumbism.

*General Symptoms.*—General weakness in varying degree occurred in 25.9 per cent. of the cases; loss of weight based on statements of patients in 16.9 per cent., this figure being accepted with some reservation; pallor in 8 per cent. and therefore not a pronounced feature.

*Digestive Symptoms.*—Abdominal pain, the most frequent of this group, was reported in 95.5 per cent. of the cases. This varied widely in intensity, *i.e.*, from severe colic wholly incapacitating the patient to slight griping or dull pain. As a rule it was not sufficiently severe to be designated as colic; in the majority of instances it localized in the umbilical region, in others generally in the lower abdomen, in still others in the epigastrium. Some patients described the attacks as entirely irregular as to time and frequency; others reported them as more apt to appear during the night; in other cases the pain appeared to be initiated by eating or it would be continuous over the twenty-four hours with remissions and subsequent return. In a considerable number, after the acute stage had passed it would appear at regular intervals after meals. Abdominal examination failed to bring out any general or localized tenderness or spasm in any of the cases reporting abdominal pain.

Constipation was present in 75.9 per cent. of all cases. It was usually reported as having been present in varying degree for several weeks prior to the attack. In other well-defined cases it was not present at any time. It will be noted that diarrhea, rarely reported by some observers, was not present in this series. Practically all the patients stated that it had been their practice to take Epsom salts once or twice a week regularly since

being engaged in the work. The impression appeared to be prevalent that this measure would have a prophylactic effect. It may be here noted that 21.1 per cent. of the gas welders inspected in September, 1924, complained of persistent constipation; of those inspected in November, 9.6 per cent.

TABLE 9.—DISTRIBUTION OF SYMPTOMS IN THE 112 CASES OF PLUMBISM

| SYMPTOMS | NEGATIVE | POSITIVE | |
|---|---|---|---|
| | Number | Number | Percentages |
| *General* | | | |
| Weakness | 83 | 29 | 25.9 |
| Loss of weight | 93 | 19 | 16.9 |
| Pallor | 103 | 9 | 8.0 |
| *Digestive* | | | |
| Abdominal pain | 5 | 107 | 95.5 |
| Constipation | 27 | 85 | 75.9 |
| Anorexia | 54 | 58 | 51.8 |
| Vomiting | 73 | 39 | 34.8 |
| Nausea | 69 | 43 | 38.4 |
| Distention | 94 | 18 | 16.0 |
| Metallic taste | 90 | 22 | 19.6 |
| Diarrhea | 112 | 0 | 0.0 |
| *Sensorial* | | | |
| Headache | 58 | 54 | 48.2 |
| Vertigo | 91 | 21 | 18.7 |
| Fainting | 0 | 0 | 0.0 |
| Insomnia | 97 | 15 | 13.3 |
| Depression | 104 | 8 | 7.1 |
| Mental confusion | 112 | 0 | 0.0 |
| Memory failing | 112 | 0 | 0.0 |
| *Neuromuscular* | | | |
| Pains in joints | 95 | 17 | 15.2 |
| Pains in chest | 100 | 12 | 10.7 |
| Muscular cramps | 107 | 5 | 4.5 |
| Tremors | 110 | 2 | 1.8 |
| Paresis of hands or wrists | 112 | 0 | 0.0 |
| Anesthesia or paresthesia | 112 | 0 | 0.0 |

Anorexia was reported in slightly more than half of the series; vomiting in 34.8 per cent.; nausea in 38.4 per cent.; complaint of distention in 16 per cent.; and metallic taste in 19.6 per cent. Vague symptoms of indigestion were common sequelae.

*Sensorial Symptoms.*—Nearly one-half of the series, or 48.2 per cent.,

reported headache; usually frontal and bilateral, occasionally temporal, and often associated with pain in the eyeballs. There was great variation in severity and duration, lasting from a few days to a few weeks; at times continuing as the outstanding symptom after abdominal pain had largely subsided.

Vertigo was present to the extent of 18.7 per cent. and usually in a mild transient form occurring during the first few days. Acute syncope was not reported. Insomnia appearing in 13.3 per cent. of the cases seemed to be a nervous symptom and not incident to abdominal pain or headache. Mental depression was noted in a few scattered instances but only to a slight extent.

*Neuromuscular Symptoms.*—Pains in the joints, in the order of frequency, were referred to knees, hips, shoulders, and elbows; the pains were of a dull character and not persistent; not correlated with any previous history of arthritis, and tending to recede with the subsidence of digestive symptoms. In two instances the pain persisted outlasting all other symptoms. Such pain was probably myalgic in character as it showed no tendency to follow the course of the nerve trunks. Pain in the chest was reported in 10.7 per cent. of the cases with no typical location. In some instances it was substernal and associated with bronchial irritation apparently resulting from the inhalation of fumes; in other instances it was referred to the front and sides of the chest. It was usually described as a soreness rather than actual pain.

There were five cases of muscular cramps all of short duration, the pain being referred to the calves of the legs and not correlated with pain or weakness of the feet. The attacks were prone to start suddenly when the patient was sitting or lying and were often relieved by walking.

In two cases tremors of the coarse type confined to the hands were observed; they were not coincident with any other nervous symptom and disappeared with the clearing up of other manifestations.

There was no indication of complaint of paresis of the hands or the wrists on examination in any of the cases in this study. There was no suggestion of weakness of the ankle joints in any instance. The strength of the hand grip was tested by means of a hand dynamometer of the Collin type, the scale, or "eschelle de traction," reading from 0 to 200. This method was used by Hayhurst (33). It was first standardized with fifty-five normal subjects made up of Hospital corpsmen and Navy Yard workmen with no history of exposure to lead. The maximum and minimum readings for the right hand were 185 and 95, respectively, the average 143; for the left hand 180 and 95, average 135. To secure uniform conditions each subject was required to stand erect, the arm fully outstretched horizontally and the hand under test rather slowly contracted to maximal power and then released. This was repeated in order to insure that the maximal power had been attained.

Fifty of the first admissions for plumbism were tested in this manner; the maximal, minimal, and average data for the right hand respectively were 190, 70, and 133; for the left hand 181, 68, and 122. The average

for the right hand of the plumbism group was 10 points lower than for the control group; for the left hand 13 points lower. In view of the wide variations recorded in the control readings, however, it is considered that the differences between the two groups are not sufficient to be significant. It appears to be established that no evidence of paresis or early extensor paralysis of the fingers is brought out in these tests.

The technic for determination of the wrist extensors was as follows: The palm of the examiner was placed upon the dorsum of the patient's outstretched hand; it was then noted whether the patient could be prevented from lifting his hands without flexing the wrists or the joints. In fifty cases examined by this method no instance of incipient or established extensor paresis could be detected.

Such sensory symptoms as anesthesia or paresthesia could not be elicited in any of this plumbism group.

The eyegrounds were not examined, but no symptoms were reported at any time suggestive of optic neuritis or other toxic eye conditions. No auditory disturbances were discovered.

*Nervous Symptoms in Relation to Duration of Exposure.*—The 112 cases under discussion are notable in that there is an entire absence of any signs of paresis or paralysis. The question naturally arises as to whether the period of exposure had been too brief to induce such nervous manifestations. The period of previous exposure for this group varied from 7 days to 13.2 months; the average was 2.4 months. There are practically no references in the literature bearing on this phase of the subject. In a personal communication to the writer Dr. T. M. Legge (4), Senior Inspector of Factories and Workshops of Great Britain, discusses the increasing number of cases of lead poisoning in ship scrapping in Great Britain during the last few years. He states that nearly all of the cases are reported as first attacks; that the patients suffered in the main from acute colic and very few from the symptoms of chronic lead poisoning such as wrist drop and chronic nephritis. He emphasizes, however, the fact that none the less there can be no doubt that with repeated exposure these disabling manifestations, which in general do not develop in less than five years' exposure to the cumulative action of lead, will appear in time.

Dr. M. D. Shie (34) states that it is impossible to put a limit on the time that a patient may absorb lead before he develops nervous manifestations. There are a great many factors which enter into this question, the most important of which is personal idiosyncrasy. One patient might develop the nervous type of plumbism in a few weeks or months, while the man working beside him might not show signs referable to the nervous system for years.

Dr. Alice Hamilton (35) is of the opinion that in a group of cases such as these under discussion one would not expect signs of nephritis so early and that as a usual thing lead palsy is rather slow in developing.

The writer is of the opinion that while these cases are of the acute type they would in all probability develop such signs of chronic plumbism as chronic nephritis with hypertension and lead palsies, if the inhalation of

lead fumes continued over a period of years, due allowance of course being made for idiosyncrasy.

*Comparison with California Group of Cases*

Reference has already been made to the group of cases reported by the Industrial Accident Commission of California (10) resulting from the use of the oxyacetylene cutting flame during the demolition of battleships at the plant of the General Metals Supply Company of the Pacific Coast. The report is dated Dec. 29, 1924, and covers the experience of eight months' work with an average daily payroll of 135 employees, and ninety cases of plumbism. Recurrences of which there were ten are included in the series.

*Digestive Symptoms.*—Loss of appetite, the complaint of a metallic taste, nausea and vomiting, and umbilical pain were fairly constant symptoms in those admitted. These have appeared usually after three or four months' exposure in the more susceptible individuals and in several cases have been noted earlier. The majority have had colic. A few have shown definite signs of lead intoxication without complaint of colic. Vomiting has usually accompanied the paroxysms. Constipation has generally been the rule, yielding rather readily to treatment. The duration of the attacks of colic has never been prolonged, the severity decreasing rapidly after the first few days.

No signs or symptoms referable to the respiratory tract or to the cardiovascular system were present. Occasional albuminuria was noted but no indications of actual renal impairment were found in any case. Vague transient joint pains were occasionally noted but no objective signs of arthritis were found.

*Nervous System.*—Paresis or paralysis was not found in any of the cases. A slight tremor of the hand was observed in a few instances. Headaches and insomnia were infrequent. Pains of indefinite and vague character, more or less transient, were now and then alleged. No definite involvement of the optic nerve was demonstrated although vague symptoms of blurred vision and photophobia were complained of in a few instances. Ophthalmoscopic examinations in such cases revealed a mild neuroretinitis which could well be interpreted as due to other causes than lead. Cerebral symptoms were entirely lacking.

The general clinical aspect of this group is in the main quite similar to the writer's group, the outstanding symptoms being gastro-intestinal. The data for blood examination, however, are quite different in the two groups. In the writer's group basophilia in various grades was far more pronounced and a higher proportion of cases showed reduction in red count and in percentage of hemoglobin.

## Preventive Measures

The preventive measures employed at this Yard are considered under four headings: (1) physical examination of candidates for employment in oxyacetylene cutting; (2) medical inspection of employees; (3) instruction in personal hygiene; and (4) protective devices to prevent the inhalation of lead fumes.

*Physical Examination of Candidates*

In addition to the usual complete physical examination all men were carefully scrutinized as to the general aspect, for evidence of a blue line, and as to the status of finger and wrist extension. They were carefully questioned as to the length of previous exposure, if any, to oxyacetylene cutting of paint covered metal, and as to previous history of plumbism. No men were accepted with a definite history of chronic lead poisoning or presenting any signs of lead absorption.

*Medical Inspection of Employees*

These medical inspections were carried out with a view to eliciting cases of lead absorption or incipient cases of plumbism in order that therapeutic measures might be taken before the onset of pronounced symptoms. This examination included all men engaged in this work and comprised the following: general appearance particularly with reference to color and gait; the mouth and gums particularly for signs of a blue line, gingivitis, and carious teeth; the presence or absence of tremor of the hand; the testing of the extensor power of the fingers and the wrists; and examination of the blood for basophilia in doubtful cases. In November, 1924, however, all men were examined for basophilia. The status of the bowels, appetite, presence of headache, abdominal pain, and incipient weakness were carefully inquired into.

Workers showing definite symptoms or marked signs of absorption were immediately admitted for treatment. Doubtful or borderline cases were kept under observation and treatment. In view of the compensation consideration a certain difficulty was met with at times in arriving at a diagnosis. It was also realized that these workers are, as others, subject to diseases and intoxications arising from causes other than work and producing certain symptoms identical with plumbism. A distinction must be made between disease "caused by the occupation" and that "concomitant with" the occupation.

*Instruction in Hygiene*

Instruction in hygiene covered such matters as regulation of the bowels, special attention to dental cleanliness, and the prompt reporting of incipient symptoms. The usual precautions of scrupulous hand washing before eating and the changing of clothing for work were mentioned as desirable in a general way. Such measures of course have no preventive value, as the mechanism of lead poisoning in this study is by inhalation and not by mouth contamination through the handling of food or cigarettes.

*Protective Devices*

The crux of the whole question of prophylaxis lies in the use of an efficient mask or respirator which will filter out the minute particles of the volatilized lead. A detailed report on this phase of the subject prepared by the safety engineer of the Navy Yard, Philadelphia, has already been submitted to the Navy Department.

In order to cut down the extent of fume production as far as possible, the paint is first chipped away in the line along which it is intended to cut. The flame, however, tends to spread beyond this area and there is always a

certain amount of residue after chipping. It is furthermore impossible to remove the red lead between the plates in the case of armor decking.

On account of the extreme fineness of the volatilized lead, the ordinary respirator such as the sponge type designed for holding back dust is entirely useless, as was brought out by actual experience in this work. The following types of masks were investigated by the Department of Safety Engineering of the Navy Yard:

1. The La France No. 1300 sponge filter type respirator, aluminium frame.

2. The La France No. 1300 aluminium frame respirator with special cup for holding sponge. cotton filter, and activated charcoal.

3. Respirator mask, sponge type, aluminium frame with pneumatic face cushion similar in design to the second type.

4. Standard Junior mask with colored lenses, shade suitable for oxy-acetylene cutting.

5. Modified Burrell industrial gas mask, the facepiece being replaced by a soft rubber respirator with type GMC-1 canister and with rubber respirator in lieu of the rubber face mask.

6. The Mine Safety Appliance Company standard mask, type M-S-A. This mask was furnished with 50 feet of oil proof hose in two 25-foot sections. The facepiece which was made of rubber was provided with suitable colored lenses. The mask was furnished with substantial reenforced trunk designed to hold a hand operated blower for supplying a continuous stream of fresh air to the operator. The above devices are all illustrated in the report of the safety engineer.

The Burrell modified industrial gas mask with type GMC-1 canister easily proved to be the most satisfactory design tested. The canister contains four absorptive layers in the following order from the bottom up: soda lime-charcoal; cotton; soda lime; charcoal; the cotton layers being one-half inch in thickness. The average life of this GMC-1 canister was estimated to be about six and three-fourths eight-hour days.

*Absorption of the Lead.*—Five Burrell canisters after being fully exhausted were examined by the chief chemist of the Supply Department of the Yard; the successive soda lime-charcoal and cotton layers being analyzed for lead. No lead whatsoever could be detected in the soda lime-charcoal mixture, all being caught by the lower cotton layer. The soda lime-charcoal stratum, however, was found to absorb certain other constituents of the fumes and to distribute the lead over the entire surface of the pad. This was demonstrated by testing the canisters with cotton layers without the chemical. The time capacity was strikingly reduced, the cotton layers becoming clogged much more rapidly by non-lead constituents of the smoke. This type of device was provided with a facepiece separate from the goggles—a distinct advantage from the standpoint of comfort. This apparatus was first used Nov. 21, 1924, and while a distinctly superior type from the standpoint of breathing comfort it failed to reduce the incidence of plumbism.

It is believed, however, that the prevalence of plumbism would have been lowered if literally all of the burners could have been induced to wear the masks at all times when

exposed to fumes. The psychologic difficulties in persuading the workers to wear the masks are in the main due to certain discomforts. The air resistance to the filters and conduits leads to inconvenience in breathing; stooping over and working in closely cramped positions aggravates this. It is therefore very difficult actually to enforce the wearing of such masks. Some of the workers reported difficulty in properly fitting the masks in certain positions with a consequent leakage at times around the facepieces.

It is believed that there is considerable room for the development of a mask with improvement in comfort and efficiency. The chief object would be to reduce the air resistance in order to secure a greater degree of breathing comfort. Laxity in wearing of the device would then be greatly reduced.

*The Army Gas Mask Modified 1919 Type of Canister.*—Preliminary tests were carried out with this type of canister but conditions were not favorable for a satisfactory practical investigation as scrapping operations were nearly complete at this time. The soda lime-charcoal mixture was removed and dependence placed entirely on the felt filter of the canister which is designed for holding back toxic smokes. With this arrangement, breathing resistance was enormously reduced and the preliminary results secured indicated a high efficiency for the felt filter.

It is difficult, in fact practically impossible, entirely to prevent plumbism in this industrial process. The risk, however, can be greatly minimized by constant attention to the foregoing various prophylactic measures.


## Summary

1. The lead poisoning in this study was induced by the inhalation of lead volatilized in fumes arising from the burning of paint adherent to scrap metal in the process of cutting by the oxyacetylene torch. The lead particles are extremely fine, being about one-half micron for the average diameter, or one-fifteenth of the diameter of a red blood cell.

2. There were eighty-three first admissions of plumbism extending over a period of observation of slightly more than 8 months—*i.e.*, from June 6, 1924, to Feb. 15, 1925—and twenty-nine recurrences, making a total of 112 cases. The number of men employed during the entire time was 221; those working not less than 1 week, 201; the average period worked per man, 3.6 months. On the basis of 221, the number of men employed during the entire time, first admissions and total cases represented 37.5 and 50.7 per cent., respectively.

3. The ages of all employees ranged from 19 to 55; 87.8 per cent. were between 21 and 30 years; 40.3 per cent., between 31 and 40 years; the average age of all men employed was 28 years; the average age of all those admitted with plumbism, 28.6 years.

4. For the eighty-three cases of plumbism the shortest period of exposure was 7 days; the longest, 13.2 months; the average, 2.4 months. Of the twenty-two first recurrences, the longest interval since the first attack was 3.8 months; the shortest, 4 days; the average, 55 days. The comparatively short periods of exposure are accounted for by the fact that the lead gains direct access to the circulation by inhalation.

5. The duration of disability varied from 3 to 69 days; the average was 20 days. Eleven cases were transferred to hospital for treatment. The remainder were carried as outpatient dispensary cases.

6. Basophilia was found in cases of plumbism in varying degree from slight to marked, and was in general a pronounced feature; only 12.9 per cent. were negative. As a control the bloods of fifty-five apparently normal persons were examined by identically the same technic and no stippled cells were found in any instance. In burners exposed to fumes but without symptoms of plumbism, 64.3 per cent. showed positive findings.

7. Anemia was present in varying degree; the red cell count was below 4,000,000 per cubic millimeter in 45.7 per cent. of seventy cases; in 44.3 per cent. it was between 2,500,000 and 4,000,000.

8. In 72.5 per cent. of sixty-nine cases examined, the hemoglobin content was below 80 per cent.; in 40.6 per cent. it was between 70 and 80; and in 31.9 per cent. it was below 70.

9. Systolic blood pressure in 108 active cases examined varied from 98 to 175; the average was 122; only 5.5 per cent. of the cases were in excess of 150. Seventy-one burners symptomatically normal in September, 1924, showed a maximum systolic pressure of 166; and a minimum of 105; in November, 1924, the corresponding data were 158 and 110. Definite cardiovascular effects therefore were not observed.

10. The blue line was positive in varying degree in 51.8 per cent. of the 112 cases. Of seventy-one men symptomatically normal examined in September, 1924, 9.8 per cent. showed a blue line; of sixty-two men examined in November, 1924, 8.1 per cent. showed a blue line.

11. There were no indications of nephritic lesions; out of seventy-eight cases examined, faint traces of albumin were reported in four not associated with other signs of renal pathology; of forty microscopic examinations, casts were reported in two not associated with albumin or low specific gravity. No indication of tendency to fixation of specific gravity was found.

12. Of twenty-six quantitative examinations in active cases of plumbism lead was found in twenty-five cases; the average quantity was 0.47 mg. per 2,000 c.c. of urine. Three examinations were made in men without symptoms, all with positive results.

13. In general the cases were of an acute type but not excessively severe; symptoms were usually preceded by persistent constipation; onset was accompanied with nausea, vomiting, headache, and abdominal pain, with rather rapid subsidence of acute symptoms; there was commonly associated a moderate grade of basophilia and anemia. Paralysis or paresis of the fingers and the wrists was absent, anesthesia and paresthesia were absent; dynamometer tests for the strength of the hand grip showed no definite impairment as contrasted with fifty-five controls. The periods of exposure were not sufficiently long to induce chronic plumbism with cardiovascular and renal impairment or the paresis and paralysis commonly observed in cases exposed to absorption of lead for a period of years.

14. The essential requirement for prevention of plumbism is a protective apparatus designed to prevent the inhalation of the lead fumes. Among the various devices tested the modified Burrell industrial gas mask with type GMC-1 canister was found to be decidedly the most efficient.

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# BOOK REVIEWS

HEALTH MAINTENANCE IN INDUSTRY. By *J. D. Hackett*, Consultant on Labor Relations; Lecturer on Labor and Employment Management, New York University; Formerly Manager, Medical Department, Nichols Copper Company. Cloth. Pp. 488 with illustrations and index. Chicago and New York: A. W. Shaw Company, 1925.

Mr. Hackett has written a book which is devoted more to practice than to theory. Though not a physician himself, he has presented material which has largely been made available by the work of physicians. Mr. Hackett has had actual experience in industry as manager of a medical department, and his approach to the problem of health maintenance is rather that of the layman than that of the physician. In many ways a contribution by a layman is a desirable one these days, as his point of view is quite necessary. Having a layman present the case of industrial hygiene has sometimes the advantage of more easily interesting the industrialist who is not as yet convinced of the value of health maintenance in industry. All through the book one sees evidence of a common sense, practical viewpoint, which is in itself a contribution worth while.

Almost anyone reading this book would readily become convinced that health maintenance in industry not only is necessary from humane considerations, but is a paying proposition. Mr. Hackett has made a fairly complete compilation of the most important contributions to industrial hygiene of recent years. Statistics are quoted usually from reliable sources, but the reliability of some of the conclusions derived from these statistics may be questioned in certain cases.

The organization and administration of health departments are discussed in detail in several chapters. There is also a chapter on mental hygiene in industry which is illuminating and interestingly written, as are most of the chapters of the book. Mr. Hackett has made a fairly careful compilation of the most important recent literature dealing with mental hygiene in industry; he presents a rather helpful and practical point of view in regard to this new science and art. There are a few chapters which describe in a popular way some of the important occupational diseases and their relation to the health of the workers and the contribution of these diseases to economic cost both to industry and to the worker. Physical examinations are discussed, and many interesting facts concerning this procedure are made plain to the reader. In fact one finds in this book almost a compendium of the practice of industrial medicine and hygiene written in popular form. One can recommend this book with comfortable assurance to personnel workers, to employers, and to anyone interested in the whole subject of industrial hygiene and medicine from the point of view of the executive.—*Henry B. Elkind.*

EMPLOYMENT AND WELFARE OF JUVENILES. By *O. B. King*. Pp. 244. London: John Murray, 1925.

The author of this little book has chosen a wide and important field to review. Every juvenile must leave school and adopt some form of occupation. The vexed question of the type of education given and how far it is or ought to be a preparation for occupation is but lightly discussed. But the need is properly stressed for care in directing the juvenile to his life's work; at present in Great Britain no fully functioning organization exists for the purpose, although the seeds have been sown in Juvenile Advisory Committees established in connection with Labor Exchanges; so far these committees have not been entirely successful and new schemes undertaken by local authorities are coming into operation.

The work to be done is extensive: social after-care with introduction to clubs, such as the boy or girl guides; medical after-care, since medical supervision ceases with school years, and national health insurance does not commence until 16 years of age; educational after-care, which should often be vocational, with attendance at evening schools; vocational guidance to replace unintelligent drift following on local and parental inclination; organization of social activities, such as play centers and unemployment schools.

Information as to health risks in industries is sketchy and not too accurate. Blind alley occupations and unguided vocational selection—the trial-and-error system—are condemned; some account is given of newer methods of selection now coming into vogue, most of which, however, are psychologic rather than physiologic; here examples are mostly drawn from American practice.

Education should be both vocational and cultural, and should provide a ladder to advanced and possible university training. Today schooling is so unappetizing that 70 per cent. of those who leave have no further use for schools; this state can and should be overcome by making instruction more amusing by introducing more practical work, and by allowing an outlet to the natural inquisitiveness of childhood. The line to be followed in evening schools is sketched, by quoting from the Birmingham curriculum which includes much handicraft. Works continuation schools are discussed and several examples are cited of the instruction given. The advantages of apprenticeship if well carried through are set forth.

Much of the work for juveniles is done by voluntary workers as a social service which, if well organized, can be invaluable.

The last chapter gives a useful summary of British law relating to the industrial adolescent. There are three appendices; the second summarizes tests used up to the present time for various processes in order to select newcomers, and, although by no means complete, is well put together; the third gives particulars and prospects in a large number of common trades.

Taken as a whole this book contains much valuable information and the author is to be thanked for compiling it.—*E. L. Collis*.